EA-87-02

Ontario

ENVIRONMENTAL ASSESSMENT BOARD

VOLUME: 81

DATE: Tuesday, March 7th, 1989

BEFORE:

M.I. JEFFERY, Q.C., Chairman

E. MARTEL, Member

A. KOVEN, Member

FOR HEARING UPDATES CALL (TOLL-FREE): 1-800-387-8810

FARR & ASSOCIATES REPORTING INC.

(416) 482-3277

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HEARING ON THE PROPOSAL BY THE MINISTRY OF NATURAL RESOURCES FOR A CLASS ENVIRONMENTAL ASSESSMENT FOR TIMBER MANAGEMENT ON CROWN LANDS IN ONTARIO

IN THE MATTER of the Environmental Assessment Act, R.S.O. 1980, c.140;

- and -

IN THE MATTER of the Class Environmental Assessment for Timber Management on Crown Lands in Ontario;

- and -

IN THE MATTER of an Order-in-Council (O.C. 2449/87) authorizing the Environmental Assessment Board to administer a funding program, in connection with the environmental assessment hearing with respect to the Timber Management Class Environmental Assessment, and to distribute funds to qualified participants.

Hearing held at the Ramada Prince Arthur Hotel, 17 North Cumberland St., Thunder Bay, Ontario, on Tuesday, March 7th, 1989, commencing at 9:00 a.m.

VOLUME 81

BEFORE:

MR. MICHAEL I. JEFFERY, Q.C.	Chairman
MR. ELIE MARTEL	Member
MRS. ANNE KOVEN	Member

A P P E A R A N C E S

MR. V. FREIDIN, Q.C.) MS. C. BLASTORAH) MS. K. MURPHY) MS. Y. HERSCHER)	MINISTRY OF NATURAL RESOURCES
MR. B. CAMPBELL) MS. J. SEABORN)	MINISTRY OF ENVIRONMENT
MR. R. TUER, Q.C.) MR. R. COSMAN) MS. E. CRONK) MR. P.R. CASSIDY)	ONTARIO FOREST INDUSTRY ASSOCIATION and ONTARIO LUMBER MANUFACTURERS' ASSOCIATION
MR. J. WILLIAMS, Q.C. MR. B.R. ARMSTRONG MR. G.L. FIRMAN	ONTARIO FEDERATION OF ANGLERS & HUNTERS
MR. D. HUNTER	NISHNAWBE-ASKI NATION and WINDIGO TRIBAL COUNCIL
MR. J.F. CASTRILLI) MS. M. SWENARCHUK) MR. R. LINDGREN)	FORESTS FOR TOMORROW
MR. P. SANFORD) MS. L. NICHOLLS) MR. D. WOOD)	KIMBERLY-CLARK OF CANADA LIMITED and SPRUCE FALLS POWER & PAPER COMPANY
MR. D. MacDONALD	ONTARIO FEDERATION OF LABOUR
MR. R. COTTON	BOISE CASCADE OF CANADA LTD.
MR. Y. GERVAIS) MR. R. BARNES)	ONTARIO TRAPPERS ASSOCIATION
MR. R. EDWARDS) MR. B. McKERCHER)	NORTHERN ONTARIO TOURIST OUTFITTERS ASSOCIATION
MR. L. GREENSPOON) MS. B. LLOYD)	NORTHWATCH

APPEARANCES: (Cont'd)

MR. J.W. ERICKSON, Q.C.) MR. B. BABCOCK)	RED LAKE-EAR FALLS JOINT MUNICIPAL COMMITTEE
MR. D. SCOTT) MR. J.S. TAYLOR)	NORTHWESTERN ONTARIO ASSOCIATED CHAMBERS OF COMMERCE
MR. J.W. HARBELL) MR. S.M. MAKUCH)	GREAT LAKES FOREST
MR. J. EBBS	ONTARIO PROFESSIONAL FORESTERS ASSOCIATION
MR. D. KING	VENTURE TOURISM ASSOCIATION OF ONTARIO
MR. D. COLBORNE	GRAND COUNCIL TREATY #3
MR. R. REILLY	ONTARIO METIS & ABORIGINAL ASSOCIATION
MR. H. GRAHAM	CANADIAN INSTITUTE OF FORESTRY (CENTRAL ONTARIO SECTION)
MR. G.J. KINLIN	DEPARTMENT OF JUSTICE
MR. S.J. STEPINAC	MINISTRY OF NORTHERN DEVELOPMENT & MINES
MR. M. COATES	ONTARIO FORESTRY ASSOCIATION
MR. P. ODORIZZI	BEARDMORE-LAKE NIPIGON WATCHDOG SOCIETY
MR. R.L. AXFORD	CANADIAN ASSOCIATION OF SINGLE INDUSTRY TOWNS
MR. M.O. EDWARDS	FORT FRANCES CHAMBER OF COMMERCE
MR. P.D. McCUTCHEON	GEORGE NIXON

APPEARANCES: (Cont'd)

MR. C. BRUNETTA	NORTHWESTERN ONTARIO TOURISM ASSOCIATION

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I N D E X   O F   E X H I B I T S

---Upon commencing at 9:00 a.m.

THE CHAIRMAN: Good morning, ladies and gentlemen. Be seated, please.

Ladies and gentlemen, the Board would like to announce a slight schedule change, and that is for the day April 3rd, something has come up that will mean that the Board will not be able to sit that day.

We are suggesting that that week we sit Tuesday through Friday instead of Monday through Thursday, and we would commence on Tuesday at one and leave on Friday at the normal time.

Are you ready, Mr. Freidin?

MR. FREIDIN: Yes.

DAVID LOWELL EULER,
PETER PHILLIP HYNARD,
JOHN TRUMAN ALLIN,
RICHARD BRUCE GREENWOOD,
CAMERON D. CLARK,
GORDON C. OLDFORD, Resumed

CONTINUED DIRECT EXAMINATION BY MR. FREIDIN:

Q. Mr. Greenwood, could you advise the Board of the subject matters that you are going to deal with in your evidence today?

MR. GREENWOOD: A. Yes. What I would like to do is build upon the evidence given in Panel 9 which dealt primarily with principles at play -- particularly at play with change within the forest but

relate those to the specific practices of harvest.

And to do that, I have organized potential effects into five areas. Rutting and compaction is the first area, erosion, micro-climate, insect and disease control, and forest diversity.

Q. Rutting and compaction, erosion, micro-climate...?

A. Insect and disease control. The last one is forest diversity.

THE CHAIRMAN: Do you have a page number for your paper in the witness statement?

MR. GREENWOOD: Yes, I do. The document starts on page 205.

THE CHAIRMAN: Thank you.

MR. FREIDIN: Q. Now, Mr. Greenwood, could you advise the Board how you intend to approach the subject matters that you have just referred to?

MR. GREENWOOD: A. What I would like to do is discuss each of those topics individually and then I would like to follow up after that evidence has been led by illustrating some of the points visually with slides.

Q. Mr. Greenwood, the first topic then of compaction and rutting, could you advise the Board what compaction of the soil is and what rutting of the

soil is?

A. I find when you are discussing this topic it is easiest if you visualize the soil as a combination of rigid particles and air spaces. And for purposes of study, those air spaces are grouped into two sizes; the large size is called macro-pores and the smaller size which is defined as micro-pores.

And compaction is simply pressure which is exerted on the soil which forces those rigid particles into the larger spaces, the macro-pores, and in doing so it reduces the macro-porosity of the soil but increases the micro-porosity of the soil, so the number of micro-pores is increased.

Rutting is simply downward pressure that exceeds the ability of that soil to hold together. The friction which is holding the particles together is exceeded, the soil fails or shears and, therefore, you get a depression forming. Rutting really is just compaction of the soil on the bottom and sides of a depression.

Q. How does pressure occur which can have this effect?

A. I think Mr. Armson spoke to this briefly. It comes as a result in harvest of travel of heavy equipment and is particularly the case where that

equipment travels repeatedly over the same ground.

Q. Is the potential for these direct effects of harvest the same everywhere?

A. No, it is not.

Q. And could you explain why the potential is not the same everywhere?

A. We have heard in previous panels about the great site variability that is within the area of the undertaking and that is at play here as well. When looking at site factors there is really three that come into play.

Q. And --

A. I am sorry?

Q. I'mm sorry.

A. The first one is the soil characteristics and of particular pertinence here is soil texture and soil moisture in that finer textures already have fewer macro-pores and, therefore, if the number of macro-pores which are there are reduced it can have a more severe effect.

The moisture plays a role in that -- you can almost look at it as lubrication. If these rigid particles have to move and there is moisture there, they are able to move easier into those macro-pores and, therefore, compaction or in the case of the

failure from rutting can take place easier.

Now, there is some interaction between those soil characteristics in that the soil moisture which could be held in the soil is related to texture. If you have a coarse texture then it is usually fairly rapidly drained, the water moving into it moves through and out and, therefore, the moisture content that would be required to increase its susceptibility for rutting and compaction just doesn't take place.

Q. All right. And what we are describing here are the site factors which determine susceptibility to compaction and rutting; is that correct?

A. That's correct.

Q. Okay. So we have dealt with texture and moisture as being two of those.

A. Yes, the first factor is really soil characteristics of which the two important factors would be texture and moisture.

Q. All right. And what would the second site factor be?

A. Well, there is a certain degree of protection of that mineral soil which is in the forest in the form of the ground vegetation and the root network. And when equipment is operating with heavy

ground vegetation, that ground vegetation can in fact increase the flotation of the equipment and, therefore, reduce its ability to impact on the soil.

The same is true of the root network. If you have a strong root network at the top of the mineral soil it can also increase the flotation of that equipment and, therefore, reduce its effect on the mineral soil.

The third effect would be the forest floor -- or sorry, the third factor, the organic matter as was described in detail by Mr. Armson. It also can work somewhat as a cushion and protect the mineral soil. It also can play a role if it, through weathering, has been incorporated into the mineral soil -- at the top of the mineral soil in that organic matter can increase the porosity of the soil and, therefore, it can increase the number of macro-pores within the soil and make it less susceptible.

The second major factor, other than site factors, is obviously season. In terms of susceptibility, in winter where ground is frozen, the soil is just not susceptible to rutting or compaction. In the summer, some sites are not susceptible by nature of the soil characteristics and the protection, the factors that I gave a minute ago of site.

Others are always susceptible because moisture is high or the texture of the soil is so fine that in fact macro-porosity is low. And there are still others which would be susceptible under certain conditions, for instance, after rainstorms where the moisture is in fact higher in the soil.

Q. And just going back to the site factors, when you were talking about soil protection you talked about ground vegetation and the root network. I think you said that those would give some flotation to the equipment?

A. That's correct.

Q. And when you dealt with the soil organic matter, you spoke about -- it can in fact cause the soil to be like a cushion?

A. Correct.

Q. When you are talking about this cushion and you are talking about flotation, are you talking about the same thing?

A. Not exactly. When the equipment runs over the vegetation it, of course, is bending over and that spring can in fact lift the equipment off the ground.

When I was referring to the organic matter acting as a cushion, I was thinking of it more

as a sponge. It is an area that is full of air spaces and if it is thick enough it can absorb some of the shock without putting pressure on the mineral soil underneath it.

Q. Okay, thank you. During the evidence, and I think particularly during the evidence of this panel, and we have heard a lot about the special nature of the Clay Belt.

And could you advise: Do the different characteristics of the Clay Belt play any role in terms of susceptibility to compaction and rutting?

A. Yes, they do. It is not so much the different characteristics of the Clay Belt. The characteristics of the Clay Belt; that is, the site types that are there, do exist in other places within the area of the undertaking.

I think the significance of it is that it is the prevalence of those site types which are susceptible to compaction and rutting within the Clay Belt. Those site types are usually rather limited in other parts of the area of the undertaking where the site types are extensive within the Clay Belt.

I am really referring to the two main site types which exist in the Clay Belt. Within that area foresters tend to define them as uplands and

lowlands, but an upland in the Clay Belt can be as a small a 50 centimetre or metre difference, and that change within this area could put you on to a clay -- an upland clay which wouldn't have moisture right at the surface but, being a finer textured soil, would in fact be more susceptible to compaction and rutting when it is not dry.

And clays, of course, have greater ability to hold water because of the finer texture, so it is possible that they are not dry even within the summer period. That would make these sites susceptible also to rutting if in fact moisture reaches the point where that can take place.

The lowland areas are areas which are depressed and usually have the water table fairly close to the surface and, as such, have developed organic soils or organic layers that are quite deep and organic layers are susceptible to rutting, particularly when the moisture is near the surface.

Q. What are the adverse effects of compaction and rutting if they do occur?

A. There is two main effects. The first one is reduced permeability to oxygen or to air and that can, in fact, affect site productivity. The second one is it can create difficulties for renewing

the site.

Q. Can you explain how those activities -- or those effects would cause difficulties in renewing a site?

A. Well, aeration or oxygen within the soil is important in more than one way. Good aeration can favour the water, oxygen and nutrient absorption by the roots and, of course, if the roots aren't absorbing large amounts of these then that can affect growth.

And I think anybody that has a garden or house plants knows this. When the watering starts to compact the surface you usually go in and till up the soil and what, in fact, you are doing is increasing the aeration within the soil and that can affect productivity.

The amount of oxygen in the soil can also affect organisms which require oxygen to live and the ones that we are particularly concerned about here are those which decompose the organic matter, the aerobic - they are called aerobic organisms can be reduced if oxygen in the soil is reduced and, therefore, decomposition would not take place. And that is important in releasing the nutrients and in turn can affect growth.

Another factor that is affected by

aeration is the ability of water to move through the soil. If in fact you reduce those macro-pores, the water cannot move through the soil as quickly and, in fact, surface water could run over the surface as opposed to infiltrating into the soil.

In terms of the second main area, renewal, when you compact that soil you are increasing the strength of the soil and that can lead to the reduced ability of roots to penetrate the soil and that, of course, then can limit root size and growth. It can also have an effect, this increased strength, in reducing the ability of a seedling to establish.

If in fact the root can't get a footing in this soil, or if it is a planted tree and they can't regenerate and grow, then you can have less survival of those seedlings or those seedlings have less access to nutrients and, therefore, growth rate can be declined or reduced.

If in fact the rutting created the condition where water could not infiltrate into the site, you can get large areas of ponding on a site which obviously reduces the area, the micro-site which can be either planted or seeded or on which natural regeneration can take place.

Q. Does current timber management

practice address the potential for the effects that you have described, Mr. Greenwood?

A. Yes, they do. And in terms of some of the definitions that were given by Mr. Clark, they particularly take actions to prevent or minimize both these effects.

Q. And what are the actions that are taken in order to prevent or minimize these potential effects of compaction and rutting?

A. I think Mr. Oldford spoke to the first one that I would like to speak to in some detail and that is modification of equipment. In fact, I think that was even shown in some of the slides that he referred to.

This is quite prevalent in the Clay Belt where susceptibility is high. Within the Clay Belt traditionally the areas were harvested in winter, this was when harvest, throughout the whole area of the undertaking, was in fact a winter operation which was based on river driving in the spring, you had to have the logs on to the water in the spring. Throughout this period of time there was, of course, no effect with the ground being frozen and using horses.

With the advent of mechanized harvesting in the 50s and 60s, it became important from an

economic sense to keep that equipment working year round and particularly in the 60s there were attempts -- 60s and 70s to keep that equipment operating in the summer season. Those attempts resulted in rutting, particularly, and reduced ability to renew the site and developments took place then which led towards these high flotation or wide tires and with that development the equipment was able to work year round without creating the rutting. As well, wide tracks would be modification of equipment as opposed to narrow tracks which allows that equipment to work year round.

A second action that could be taken would still be to modify the time of year of operation. This is particularly an action that can be taken outside the Clay Belt where susceptible sites are not as prevalent, in fact are rather small in area. It is normal practice that in these areas when the sites are encountered they are set aside and harvested in winter.

Q. These are the sites which are susceptible to these effects?

A. That's correct. The use of modification of equipment is particularly prevalent within the Clay Belt because of their inability to move to other sites which aren't susceptible.

A third area would be to modify the skid trail patterns within an area that is susceptible. If you have modified the equipment so that it can operate within that area, you can minimize any effects even further by modifying the pattern with which that equipment operates.

Mr. Armson -- or Mr. Oldford referred to the Ardco, he drew a picture of it the other day, which is a forwarder which can carry three times the load of a normal skidder and by doing so limits the travel across an area. Where the skidder would have to make repeated trips to the roadside, this machine would only make a trip one in three times compared to a skidder.

Those would be three areas that -- or actions which could be taken to minimize or prevent compaction and rutting.

A third area that is again particularly prevalent in the susceptible area within the Clay Belt is training of equipment operators, particularly training to recognize sensitivity to compaction and rutting. It is obviously the operator who is in charge of that machine that can have the largest impact once they are on a site and the minimization. And I have some slides later that I think will demonstrate this point a little better.

Q. In terms of modifying skid trail patterns, the example you gave was one where you use a different piece of equipment and, therefore, didn't have as many trips from the -- sort of from the cut-over area to the roadside.

If you are using skidders and you are -- to get the trees to roadside and you find out that you have an area which is susceptible if you continually go over the same area, can you modify your skid trail patterns using the same equipment, though?

A. Yes, you would -- even with the use of high flotation equipment, you would still limit the use of that equipment to specific areas so that, in fact, if there is slight disturbance it is restricted to a small proportion of the area.

Q. Does rutting or compaction still occur, Mr. Greenwood?

A. Yes, it does, to a limited extent.

Q. And are you able to indicate where it occurs to a limited extent or why -- and why it still occurs?

A. When I was describing site factors, one of the sites that I described was those sites which are only susceptible under some conditions. And it does happen where a site has equipment on it and has

not been susceptible, but due to a change such as a weather pattern, rain for two or three days, the site could become susceptible and in the process of this sometimes equipment is still operating and can in fact create a minor amount of rutting, particularly.

There are also sites which overall are not susceptible, but in very small patches or places may be susceptible; that is, there may be a wet spot within the site of a smaller area and if the equipment was to move through that site it could in fact create rutting within that particular portion of the site.

Q. You indicated that if you were on one of these sites where weather conditions changed and operations continued you may get a minor amount of rutting. Could you perhaps give the Board some idea of what you mean when you say a minor amount of rutting?

A. Well, the rutting that I have seen under those circumstances, again, would be the small patches, like wet patches. Sometimes those are only the size of a skidder and normally operators would try and avoid these.

Obviously if they are sitting in a wet pocket they aren't being very productive. So, again, it would be part of normal operations to avoid these.

It could also be where the rain is

starting to fall and wheels are starting to slip on hillsides, things like that. So it would normally be restricted to where the equipment is travelling and in isolated patches of where that equipment is passing.

Q. Okay. In our opinion, would the rutting or compaction which does occur from time to time, as you have described it, does the kind of rutting or compaction that you are speaking of result in a significant reduction in productivity of the site?

A. In the case of compaction, I am not aware of any measured losses in productivity except possibly where roads and landings have been regenerated and there has been compaction on those roads and landings.

When you consider rutting, with the modification of operations and the actions taken to prevent and minimize, the occurrence is really low and is limited to a number of the susceptible sites -- site types, or actually the number of susceptible site types is limited is really what I am saying.

The duration of that susceptibility on those sites, particularly those which change the susceptibility, is usually relatively short. If it is a weather pattern, it dries out almost as quickly usually as it became susceptible, and during that

period of time equipment operators may in fact be able to move to another portion of the site or an adjoining site and not create any effect.

So overall the areas of rutting are small and isolated and generally wouldn't affect productivity to any significant effect on a site.

Q. And, again, could you put in general terms some sort of dimensions on what you refer to as an isolated patch or a small patch of susceptible ground?

A. Maybe the best way would be just to give an example. I have mentioned that this occurrence is generally restricted to where the equipment is operated in a repeated fashion.

The example that I have in my mind would be where equipment has been operating on a site which has not been susceptible and increase in moisture through precipitation has made it susceptible and there may be a slight slope, 10 or 15-foot slope that the equipment is having to operate up and down a short slope within the site.

If the equipment operates on that slope repeatedly, it may in fact -- the moisture may cause wheel slippage just the duration of that slope which could in fact cause ruts or compaction on that slope.

So it may be an instance where it is only 10 to 15 feet long where the equipment is trying to get up a slope.

If it was in fact a long slope -- the grading of our slopes in Ontario are such that you normally wouldn't get that type of slippage over the long distance, and if it was that steep the equipment wouldn't be able to operate on it.

Q. Okay, thank you. How does a forester determine whether the sites that are to be harvested are ones which are susceptible to compaction and rutting, and also how would they determine or assess the degree of susceptibility of compaction and rutting if in fact they thought that it was going to be susceptible?

A. Well, the ones that you would normally key in on are the those soil characteristics and they can in fact be measured either directly or indirectly; directly through field observation or the results of field observation, or indirectly through interpretation of the vegetation which in fact reflects soil texture and soil moisture.

Q. When we deal with directly determining those factors, I think it was maybe Mr. Armson that indicated that on occasion the forester might get out there on the site and kick the duff. And

could tell certain things about the soil characteristics from doing that? Do practising foresters do more than just kick the duff on occasion?

A. I've got to admit I have kicked the duff and I have got boots to show it, I guess, but I carry a shovel with me and I think a lot of foresters did. I think I heard Mr. Hynard say the other day he did the same thing.

And if in fact I was concerned about the soil characteristics on the site and had the opportunity to measure it directly, I would go into the site with a shovel and in fact dig a soil pit and take a look at what the soils were.

Q. Now, you indicated that you could determine some of these factors, and particularly soil characteristics indirectly. And could you perhaps expand on how you are able to -- or foresters are able to make those types of determinations about soil characteristics indirectly?

A. Well, I think I mentioned a minute ago that if you were determining them indirectly you would be interpreting the vegetation as it reflects the characteristics of site which in fact make the site susceptible, and there is more than one way of doing that.

The first way, and the way which is most common in the Clay Belt area and in fact came about as a result of some of the susceptibility in the Clay Belt area, is the forest eco-system classification system. This is a formalized use of vegetation as an indicator of the site and, in fact, of the site factors of moisture and soils.

Q. Now --

A. Sorry?

Q. I was going to ask you, that if a forester doesn't have this formalized document, this forest eco-system classification which gives him this relationship, are they able to make an assessment of the soil characteristics through observations of the vegetation on the site?

A. Very much so. Part of the formal training and in fact part of the experience a forester gains is in doing just that, it is interpreting vegetation as it relates to site for more than one reason.

When you go into the existing forest it gives you an indication of what's there and sometimes you are trying figure out why it is there. So you are constantly examining these relationship, particularly because it has importance when you are dealing with the

renewal program.

If you don't understand the relationships between site and vegetation you will have a difficult time making prescriptions, the best prescription for that site. So these relationships are something that are taught in a normal sense and, in fact, are more refined as that forester becomes more experienced, particularly on their local area where they get to know the relationships quite well.

In terms of the FEC, many of the relationships which are embodied in a formal way in the FEC came from the knowledge of foresters who understood those relationships. I guess the significant difference is that each forester tends to create a model in their mind of those relationships and they may not always be able to communicate that model effectively.

I may be talking about a jack pine site with Labrador T and have a very definite site in my mind, when a fellow forester might also be thinking of jack pine and Labrador T but have a little different site in mind. By formalizing those relationships in something like a FEC, you are able to communicate and, therefore, pass knowledge better.

I mentioned the FEC first, being the

formalized system. There are -- this knowledge of relationships then allows the forester to interpret the vegetation from other sources of information and the key one that I am thinking of here is aerial photos.

If you understand how canopy vegetation relates to soils and moisture, you can in fact interpret susceptability of the site to various things patching and rutting, erosion and with that knowledge and ability of interpreting the canopy vegetation you can in fact interpret the site from flyovers as well.

And I guess the big advantage of a flyover as opposed to aerial photos is that you can get closer to the ground and get an indication of the ground vegetation which would allow you to refine your interpretation even further still.

Those would be three ways of indirect that in fact exist in the area of the undertaking now.

Q. How much can you actually tell from the indirect methods of aerial photographs from flying over an area?

A. That would depend to some extent on this experience that I spoke about. The basics are there, as soon as you go to the field jack pine doesn't normally grow in very wet sites, black spruce can, so

that the broad basics are in fact understood, but as you get to know your particular area you can in fact reduce the number of relationships that you are having to interpret.

For instance, there are some management units which have no clay on them at all, so that an understanding of the relationships between vegetation and clay would not be required by that forester.

If in fact the unit is fairly coarse materials that forester through experience may gain a better understanding in interpreting to a refined -- a more refined level the coarser types. So experience and the terrain would both play a part and I think you can tell a lot from these actually.

Q. Okay. You gave sort of one example of how you might make -- go into a stand, as you indicated you might -- a jack pine stand and there was Labrador T I think you said.

A. Mm-hmm.

Q. And that would mean something to a forester, he could come to some conclusions about the site based on those observations?

A. That's correct.

Q. Can you sort of perhaps expand on that one and give a couple of other examples of how a

forester, by making observations within a stand, can in fact come to reasonable conclusions about the characteristics of the soil in the stand?

A. If I understand you correctly you would like me to explain what a forester would look at going into a stand to determine some of these relationships other than the vegetation, other...

Q. Well, I am concerned about a forester's ability to come to sort of conclusion as to what the soil characteristics are.

As I understood your evidence you indicated that when you go into a site that there is -- and you see certain vegetation, there is a relationship between the vegetation you see and the type of soil that one could reasonably expect in that situation.

A. Yes.

Q. And I just would like maybe two or three sort of real life examples--

A. Sure.

Q. --of where you might do this?

A. I keyed in on the vegetation - I think I understand - I keyed in on the vegetation because I think that tends to be the focus of what we are looking at, but there are a number of other factors that would be utilized by a forester or a forest

manager in determining that.

If I could go back to the aerial photo example. Land form, the geological land form that the vegetation is on is very important in determining the characteristics of soil. You can in fact interpret glacio-fluvial deposits, that is waterlain deposits - I think Mr. Armson defined those in Panel 9 - and those, the waterlain deposits tend to be the coarser deposits, the sands and the gravels, and there are a number of cues that you could pick up on in aerial photographs that would tell you that you are in a glacio-fluvial deposit.

That would be quite different, for instance, when compared to a lacustrine deposit which is in fact a deposit which has been waterlain as well but by standing water. It is in fact lake bottoms and that is where you would find your clays and your deposits. So land form would be an important characteristic.

And, in fact, even without photographs, driving down a road you would get flags or cues that would give you an idea of what land form that you are on and before you even see the vegetation or get in and check the ground vegetation, you would have an idea of what the soil is.

There is other cues that would zero in on this land form. If in fact there were large angular boulders throughout the whole area. Large boulders, particularly strewn across an area, are not waterlain, they are generally dumped by the ice as it was melting and, therefore, you would have an indication -- a good flag, a flag you could even see on photographs if the boulders are big enough that would tell you you are on a till deposit and that till deposit would be mixed types of soils. It would be fines and coarse material and rock fragments within it. And those types of soils would in fact be dry most of the time, but depending on the fines content, the fine-texture content, could be susceptible under certain conditions.

So land form and cues of land form become very important.

Q. All right. That is land form. And in terms of vegetation, can we go back to that and could you give me an example or two of how you would interpret or come to certain conclusions about vegetation or how are you able to look at the vegetation and have some idea of the kind of soil characteristics?

A. Well, the relationship as I mentioned is directly to texture and moisture. Maybe again I

should just give some specific examples.

If I had jack pine and through ground observation or observation on an aerial photograph I determined that I was on very flat topography, I could in fact determine that amount of glacio-fluvial topography with jack pine, those would be two cues that would tell me I am on a fairly dry site, coarse-textured site and a site that wasn't particularly susceptible to compaction or rutting because of the coarse nature of the site.

If I was able to get an indication of ground vegetation, I could refine that even more. If in fact the ground vegetation was strictly lichen, I am on a very, very dry site, no undergrowth, that would be a far drier site than the Labrador T site that you referred to and which would be drier again than a site that had herbs underneath the jack pine, herbacious growth. So you can refine it further depending on the level of information you have.

If in fact the overstorey vegetation was a mixture of jack pine and poplar, I would have a cue that I am probably on a more moist site, a fresher site just by that overstorey and I could confirm that again by looking topography, if it was underlaying topography, if it was in fact strewn with boulders I

may be on a till deposit. I have got a finer texture in that soil and that could also be reflected in the ground vegetation.

The third one would be an area that is depressed; it is flat, it is lowest in topography, it has pure black spruce on it, I have a pretty good indication that such a site would or could possibly be an organic site, high water table and, therefore, would be susceptible to compaction and rutting.

Q. Okay, thank you. Now, there was some discussion the other day I guess through Mr. Oldford about different soils and the importance of the operators in terms of ensuring that compaction and rutting doesn't occur.

Have you been able to -- well, is any information available for operators, that you are aware of, that would be useful to them in terms of dealing with sites and how they should operate, what good practice on those sites might be?

A. Yes, yes there is. Some of the broader classifications of land forms and vegetation types have been recorded in tables. I have an overhead that might help with that.

Q. Perhaps we can dim the lights.

MR. FREIDIN: I have a copy of that, Mr.

Chairman. Well, perhaps I will hand this out.

Q. Is there only one overhead that you are going to be using?

MR. GREENWOOD: A. Yes, there is.

MR. FREIDIN: Okay. (handed)

THE CHAIRMAN: This will be Exhibit 461.

---EXHIBIT NO. 461: Hard copy photograph of table taken from booklet entitled: Terrain Classification for Canadian Forestry produced by FERIC.

MR. GREENWOOD: This table was taken from the little booklet that was produced for operators practising -- field people, called: The Terrain Classification for Canadian Forestry. It deals with the boreal forest right across Canada and describes some of the broad relationships between land form, vegetation and soil moisture and soil texture.

It was produced primarily to allow operators to get an indication of trafficability of a site and, of course, if the site has low trafficability it in fact could be a site that is susceptible to rutting and compaction.

This was produced by the Forest Engineering Research Institute of Canada, FERIC.

MR. FREIDIN: Mr. Chairman, could that excerpt from that document be marked as the next

exhibit.

MS. SWENARCHUK: Excuse me. Could you give me the title of the document again, please?

MR. GREENWOOD: Certainly. Terrain Classification --

MR. FREIDIN: Oh, I didn't hear you, I was busy.

THE CHAIRMAN: We already marked it.

MR. FREIDIN: What was it?

THE CHAIRMAN: 461.

MR. FREIDIN: 461. Thank you.

MR. GREENWOOD: Terrain Classification for Canadian Forestry, a 1980 publication of the Forest Engineering Research Institute of Canada, FERIC.

It just sets out some of those broad relationships that I was referring too.

In the centre it talks about surface deposits and in fact when describing land forms it can be interpreted, and then it goes to two levels of refinement, the overstorey vegetation and the forest vegetation, again which I referred to, and the ground vegetation which I referred to.

And, in a general way, the bottom line shows the pressure required to operate on that site to maintain productivity. By pressure, I mean the ground

pressure. If we go up in the table it relates it to the two key characteristics that I referred to, the moisture and soil texture.

MR. FREIDIN: Q. Now, Mr. Greenwood, as you know I am terrible at interpreting things such as this. Perhaps you could just take us through a couple of those boxes and just tell us how we are to interpret this. How would you actually read it.

MR. GREENWOOD: A. Okay. We start right in the first block beside surface deposit. It is the mention of types of deposits here, glacial deposits, dune which is an aeolian, a windlain deposit or glacio-fluvial deposits, waterlain, moving waterlain deposits. And the table is telling us at the top that that, in terms of trafficability is very good, it is one, as opposed to the other extreme which is very poor on the other side of the table.

It is telling us that it is -- in terms of soil moisture, it is a freely drained, rapidly drained site, so the water that is in the site is moving through it, it is not being held. It is telling us that that type of deposit would normally have coarse sand or gravel.

If in fact it was a dune, it would be fine sand, pure fine sand though without any silt

content. So it is giving us an indication of the soils that are there.

Another flag as to what the trafficability would be is given by the species that could grow on that type of site. Normally on that type of site the key species would be jack pine which is particularly adapted to the limiting factors of a dry site. You could, however, have black spruce particularly if it is a mixture with jack pine or, to a lesser extent, white birch and aspen.

The groundcover, you could examine it. It could be lichen, if it was extremely coarse, it was a coarse gravel deposit the only thing that may be able to grow on it is lichen.

It could be any one of three other plants that they would suggest are indicators on such a site, bear berry, grass or feather moss. On that type of site, the two that would be probably most common would be feather moss and lichen.

Q. And the bottom line there is that is basically the information which would -- could have some indication as to the equipment that you could use on that site; is that true?

It says approximate rated machine footprint pressure required.

A. That's correct. It would be related to the equipment that you could use or the equipment that -- the ground pressure of the equipment you should be using if you want to maintain trafficability.

Q. And what do you mean by trafficability?

A. Ability to move around on the site. An importance -- obviously when you have got equipment on the site, of importance is productivity. If in fact the equipment is unable to manoeuvre and move on the site easily, you can reduce productivity as well as create disturbance effects such as rutting.

In fact, the two go hand-in-hand rather nicely in limiting the potential of this effect in that when trafficability is low that is when you have a condition where you could create compaction or rutting, but it is also the point where productivity of that equipment gets low and the equipment operators obviously would prefer to be productive than non-productive.

Q. Could I refer you to the witness statement, Mr. Greenwood, and in particular page 491.

A. Yes, I have it.

Q. Now, page 491 is part of the section which outlines conclusions - the conclusions start on

the page prior - of an article by Schurman and Mackintosh. The actual article or the study starts on page 468.

And my question for you -- the first question is: Can you advise why this particular document was included as part of the witness statement?

A. I utilized this article because it gave a good description of the science involved in compaction and rutting particularly as it related to our most susceptible area.

Q. I believe it has a description of this macro-porosity micro-porosity that you have already spoken about?

A. Yes, it does.

Q. And on page 491 there is a comment, if I can read to you or refer to you the first two sentences on page 491:

"The study should be viewed as a preliminary problem analysis on the susceptability of forest soils to compaction in northern Ontario. To determine the potential effects of logging in this region, more extensive research is needed on both mineral and organic soils."

Could you advise: Have more detailed studies been undertaken as suggested by the authors of this particular document?

A. Not to my knowledge, no.

Q. And could you advise why not?

A. This particular document in the authors' mind, even his conclusions was a preliminary problem analysis, whether in fact there was a problem there which warranted further study.

I think probably one of the key reasons why further work wasn't requested by the Ministry was that we had already determined that there were potential negative effects of this type of action, compaction and rutting, we didn't need further research to tell us that. Sorry.

Q. Just before you go any further, this particular study was a study conducted in the Clay Belt?

A. That's correct.

Q. Okay. Sorry, if you could just continue then.

A. There were also two developments that took place at about the same time as this study was completed. One was the release and wide-spread use of the FEC for the Clay Belt, the first FEC produced in

the province, which allowed foresters to determine susceptability of the site to a rather refined level.

A second development was the advent of the option of using wide tires to operate these areas in summer. So with the ability to determine which sites were susceptable and the ability to modify equipment to prevent or minimize that effect, in fact, we felt, or I assume - I don't know - I assume that it was felt that there was no reason to do further study.

Q. Thank you. I would like to move on and ask you a few questions about erosion. And again this is a topic I think that was referred to by Mr. Armson in Panel No. 9 and I think perhaps by some of the witnesses on this panel.

Could you perhaps define what erosion is?

A. In a simple sense erosion is just the movement of soil particles by a transporting agent and the two transporting agents are wind and water, particularly flowing water -- or only flowing water.

Q. I understand then that in your evidence that you will be referring to wind erosion or water erosion to make the distinction?

A. That's right.

Q. Can erosion occur due to harvest?

A. Yes, it can, although I would

suggest, as Mr. Armson has said, that it is extremely limited. One has to be careful to separate erosion from roads or landings, if they exist, from that which occurs from the harvest operation across the site and when you do this there is very little potential for erosion from the harvest site.

Q. Erosion can occur as well from the construction of roads; is that correct?

A. That's correct.

Q. And are your comments today and your paper intended to address the potential for erosion from roads?

A. No, it is not.

Q. Okay. You indicated that you agreed with Mr. Armson's observation about whether or not erosion was a problem. Are you able to -- are you basing that on your own personal experience?

A. Yes, I am.

Q. And could you perhaps indicate to the Board then what your personal experience has been which causes you to agree with Mr. Armson's comment in Panel No. 9?

A. If I could build on some comments you made on your opening remarks where you said the significance of an effect would be based on, I think

you listed four factors, the frequency, the intensity the duration and the extent of any occurrence.

In terms of soil erosion, the severity of occurrences that I have seen is extremely slight in terms of the amount of soil that is actually moved and I have never seen erosion to the point where it would prevent ground vegetation from occurring or from re-establishing on that site.

If you in fact don't reduce the ability of vegetation to re-establish on a site, then the duration of any effect is particularly short. As soon as even a slight amount of ground vegetation is re-established on the site, it will slow and in fact can almost stop the process of erosion.

In terms of the extent of any occurrence, the terrain within the area of the undertaking is quite broken. I think you hav eprobably seen that in your travels in field visits. And because it is broken, if in fact soil movement was to begin it would very quickly be trapped in the depressions which exist within that terrain and, therefore, the movement of soil is quite limited even if the conditions were created to allow it.

The potential frequency is the last point I think you mentioned. And in terms of the area of the

undertaking we talked about the high permeability of the soils. The high rate of infiltration throughout most of the area of the undertaking, both due to the nature of the texture of the soils itself plus the fact that the organic matter just isn't disturbed to a significant extent on areas that are harvested. And because of those two factors the actual frequency of any occurrence, again, is very slight.

Q. You indicate on page 248 of the witness statement that soil erosion is a natural process. Could you explain what you mean by that?

A. What I was really referring to here was the fact that erosion is always taking place in our environment, particularly along watercourses and drainage ways.

So when we are talking about erosion, we are not talking about an on/off situation, we are talking about accelerated erosion. And I guess the second point of calling it an actual disturbance -- sorry, a natural occurrence is the fact that disturbance takes place regularly within our environment and disturbance, whether it is man-caused or natural, can accelerate this erosion.

Q. Have you ever measured the amount of erosion or gathered data on its occurrence following

harvest?

A. No, I have not. In fact, I am not aware of any studies in Ontario or for that matter eastern Canada that has in fact measured erosion from a site as a result of harvest and that would be as opposed to roads.

The other thing in terms of measuring, erosion -- when I am referring to erosion, I am referring to its ability to affect productivity on the forest estate and any erosion which could affect productivity in a significant way would be quite visible and it just isn't an occurrence that is visible.

Q. And your experience is not one that you have seen; is that what you mean?

A. That is correct. You mentioned experience earlier. I maybe make one other point. It is not just experience in seeing erosion. The factors which control erosion I think are fairly well understood, it has been studied for many years, probably centuries, and an understanding of those principles plus an understanding of the conditions which occur after harvest is what would allow one to come to the conclusion that the potential for erosion is very slight.

So it is not just observation of visible erosion or lack thereof, it is observation of the conditions which exist following harvest when compared to the conditions which would need to exist for erosion to take place.

Q. Okay. Well, that gets me really I think into the next area of this topic of erosion that I would like to get into and that is, that even though the occurrence of erosion is not significant because of harvest, would the factors which could lead to erosion be the same regardless of the timber management activity that you were considering?

A. Yes. I have been limiting my remarks to harvest but in fact those principles -- the factors would create -- would apply to all practices in timber management.

Q. All right. Well, it's those principles and factors that I would like to get into.

Do I understand that it will be important to understand these factors or these principles not only for understanding your evidence in this panel, but it will in fact enable a better understanding of evidence to be given in later panels?

A. That's correct.

Q. All right. So let's just deal with

these factors or principles for a moment. What sort of conditions must exist before a site will erode?

A. Well, there is two key conditions that I think you have to keep in mind. The first is that the soil itself, the mineral soil has to be exposed over relatively large and continuous areas.

By exposed I am referring to removal of the forest floor. With the forest floor in place at litter layer, the duff layer promotes infiltration of water into the soil which leads me to the second key factor, you have to have an agent of movement something that can move the soil, and we referred earlier to wind and water.

In the case of the removal of the organic layer, it is that removal which exposes the soil to those agents of wind and water and if that soil isn't exposed then it can't erode.

Q. Is the removal of the forest floor and the resulting exposure of the soil to wind and water common as a result of harvest?

A. No. As I have already said, I think that occurrences are very slight, limited in extent.

Another factor that you have got to keep in mind when looking at erosion in the area of the undertaking is the fact that we have winter for about

half a year and under winter conditions the soil is frozen and it can't -- it would be more difficult to erode, particularly if it was protected in a blanket of snow, but if operations take place during this time, it would be very unlikely that you would affect that forest floor.

Q. Now, where exposure of the mineral soil does occur, are all sites equally susceptible to erosion?

A. No, they are not.

Q. All right. And could you explain why all sites are not equally susceptible to erosion when you have that exposure of the mineral soil?

A. Like compaction and rutting, probably the key characteristics relate to the soil itself. Even if the soil was exposed, it would depend on the texture that's there -- or the texture that's there would determine whether the potential for erosion was significant or not.

If you expose a coarse sand, the coarseness of the sand would prevent wind from moving it to any great degree and the coarseness of the sand would prevent surface runoff from the area. If water hits that exposed sand, it would infiltrate into the sand and, therefore, not move over the surface and not

create the action necessary to erode it with water. So the soil texture is a key factor.

The second key factor would be the abundance, or particularly the lack of stablization factors on the site and there are -- these would equate I guess to some of those protection factors that I mentioned in compaction and rutting. Roots, again, can hold soil to prevent its movement. The depressions in the terrain that I spoke to which could limit any occurrence would also be another stablization factor.

Q. Okay. You gave an example of a soil texture, coarse sand, which would militate against erosion occurring. Could you give an example of a soil texture which would perhaps be more susceptible to erosion if it was exposed?

A. The texture that would have the highest potential -- in fact, really within the area of the undertaking the only significant potential for wind erosion is a pure fine sand. I think this was referred to by Mr. Hynard in his evidence, he referred to a silt-free fine stand.

By pure fine sand we mean that it does not contain significant amounts of sand particles of different sizes, they are all fine, they aren't coarse, they aren't very fine and there is no component of

other materials like silt in that sand. For wind erosion to occur you would also have to have not only the fine sand but the lack of those stabilizing factors.

Q. All right. And in terms of water erosion, are you able to indicate a soil texture which would be perhaps more susceptible to that occurring if you had all the conditions occurring, more susceptible than this coarse sand that you refer to?

A. Yes. The finer-textured soils tend to be more erodible by water.

When we are referring to water erosion there is maybe something else, we are talking about susceptibility by texture. A point that I haven't mentioned is that for water erosion you not only have to have the susceptibility of the site in terms of texture to create erosion, but the site has to be susceptible to water movement as well, surface runoff.

So obviously the site must have some slope. If it is flat, the susceptibility for water runoff is greatly reduced.

The forest floor, again, is an important point. If the forest floor is in tact or if its integrity is in tact, then you would not get surface runoff, the water would infiltrate the forest flow --

the forest floor and run below surface.

Another factor that may play a part in surface runoff is reduced soil porosity. So if compaction had taken place on a site you could in fact create conditions for soil -- surface water runoff. So in terms of water erosion, you not only have to have a susceptible soil, you have to have the soil in a condition where water runoff could take place.

Q. And I understand that in Panel 11 there is going to be evidence about site preparation which in fact involves, in some cases, the intentional exposure of the soil?

A. That's correct.

Q. And I don't want to sort of get into Panel 11 at all, I understand that you will be a witness there as well, but does that activity where you intentionally expose the soil, does that increase the potential for erosion?

A. Yes, it does. And when we in fact carry out site preparation operations, or when we are doing those descriptions, the prescription of equipment and its use would take into account the factors which could accelerate erosion.

Q. All right. And we will be dealing with that in Panel 11?

A. That's correct.

Q. Where did you learn about these principles or factors which are relevant when assessing susceptibility to erosion, Mr. Greenwood?

A. I mentioned a minute ago that the principles have been well known for a long time and I am sure that from before I got to university - though, I don't remember - I understood some of the basic principles of erosion. However, in university, in Faculty of Forestry, they related the practices of timber management particularly to the principles of erosion. So it was part of my academic training.

Q. Does the understanding -- in your personal experience, does the understanding of these principles vary as between foresters?

A. I think the understanding probably would vary, yes, in that, I suppose depending on your academic training, there may have been focuses which were different between foresters.

However, it has certainly been in my experience that all foresters that I have worked with have an understanding of soil erosion and the effects of timber management practices to a level that allows them to make reasonable silvicultural and harvest decisions.

Q. You described --

MR. FREIDIN: If I can just have one moment, Mr. Chairman.

Q. When we dealt with the subject matter of compaction and rutting, you indicated some of the sources of information or cues that a forester might have as to whether your site was susceptible to that or not, you referred to land forms and you referred to the FEC and such things.

Where does a forester get information which would allow the forester to apply the principles in terms of erosion that you have described?

A. When I discussed compaction and rutting I grouped the information into two areas, direct and information -- direct and indirect sources. The same would be true for erosion. The direct sources certainly exist, you can go out to the field and observe directly some of these factors.

It may be through the direct observations of others that the information becomes available; it may be through those direct observations, for instance, which are recorded in a soil survey, there are -- or a land form map, we talked about land forms affecting texture.

There are also indirect methods which

apply equally to erosion, aerial photographs, flyovers of the area. There is a number of different methods of direct and indirect sources of information, methods or sources of information.

Q. All right. Are these sources of information available to field foresters?

A. The majority of the sources are readily available throughout the area of the undertaking, yes.

Q. And when you say the majority of the sources are readily available, does that mean there are some sources which aren't readily available? I am not too sure exactly what you mean when you say that.

A. Yes, I think that's what I meant. For instance, I guess an example, soil -- detailed soil surveys that would give you the detailed level of information necessary to determine susceptibility to erosion do not exist throughout all areas of the undertaking. So that would be one that wouldn't be available everywhere.

Q. All right. So when you say the majority of these sources are not readily available, it is because in some areas they don't even exist?

A. That's correct.

Q. Okay. In your experience, do other

foresters use these tools that you have referred to in the same way that you do?

A. Well, I didn't do a survey of foresters before I wrote this evidence, but certainly the ones that I worked with did and that has been the experience of other foresters. It would be to a lesser or greater degree I think depending on which method you were talking about.

One just crossed my mind, that when we are talking about aerial photographs and interpreting them for things such as land forms and soil textures, some people can't see stereo using these photographs; that is, they can't see the three dimension that stereo photographs can let you see.

In a circumstance like that, it would be very difficult for a forester to use that particular tool to any great extent.

Q. Is it necessary to use all of these tools to make decisions on every site?

A. No, definitely no.

Q. Could you explain that?

A. Well, when you are looking at things such as susceptibility, and erosion is a good example, you are usually looking for -- or utilizing flags or cues that there is a potential there.

If I could use the aerial photointerpretation as an example. If you are looking at an area and determining land forms or even looking at the vegetation, a flag that might hit you is a sand dune. These are in fact visible on aerial photographs. These are sand dunes that were probably created during glacial times and they are quite large and as soon as you saw a flag or a cue such as that, you would know that the soil texture there has a potential for wind erosion.

Q. Now, a number of witnesses, and I think probably more so with Mr. Armson, have described the importance of integrating harvest and renewal decisions. If we could stick with this topic of erosion for a moment, can you indicate how this integration might come into play?

A. Probably the best way to do that would be to build on the example that I have just given.

If in fact a forester picked up a flag or a cue such as these sand dunes, there would be concern for renewal activities, particularly site preparation that would follow the harvest. The areas that would have sand dunes would normally be growing almost pure jack pine stands because of the dry nature of the site,

and jack pine does require a degree of mineral soil exposure to regenerate, particularly artificially.

So the forester would be looking at that site knowing that the renewal activity would have to provide some degree of mineral soil exposure or at least a very thin duff layer so that the roots would be in the mineral soil. And, in prescribing harvest, could possibly take this into account by prescribing clearcut, of course, for jack pine because it needs full light by using the tree-length method so that sufficient slash is left on the site to allow prescribed burn, for example.

If that forester was concerned about opening the mineral soil on that site, the concern would be for mechanical treatment, then the alternative would be to use something like prescribed burn but such a burn can only be carried out if in fact there was sufficient slash on the site to carry the burn.

So I think that's maybe an example of how picking up a cue or a flag could in fact lay into place a number of decisions or prescriptions that would show the inter-relationship between harvest and renewal.

Q. All right. And the concern about the mechanical site prep exposing -- I guess tilling the site in effect, would be a concern because of the

potential for wind erosion in that situation?

A. Yes. We talked about sand dunes here. So the potential is not for water erosion, the potential on a dry site like that would be for wind erosion.

In terms of mechanical site preparation, again, the concern would be for the degree of soil exposure which took place. If in fact the organic matter stays in place or its continuity stays in place, the degree of susceptibility for wind erosion would still be quite low.

Q. Okay.

A. But his preferred method may be a prescribed burn.

Q. Now, if erosion did occur in a significant way, would that erosion be of concern if you are talking about the effect on the forest estate, the productivity?

A. If it occurred in a significant way, yes, it could be a concern.

Q. And what would be the concern? It may be a very obvious question, but let me ask it any way: Why would the erosion be a concern in terms of the potential to affect productivity?

A. That's the answer, for the potential

to affect productivity.

Q. I guess if you wash the soil away...

A. If the -- most of the nutrients in the soil are in the upper layers of the soil, Mr. Armson talked about the weathering that takes place in the soil and that in fact within that weathered area is where most of the nutrients are. If erosion was deep enough to remove a significant portion of that soil, you are in fact removing the nutrients from the site and that can obviously affect not only productivity but the ability to renew the site.

Q. In your personal experience, are you aware of erosion which has occurred which has adversely affected the ability to renew a site?

A. Not at all.

Q. And for there to be -- and Mr. Greenwood, I understand that in Panel No. 11 the Ontario Federation of Anglers & Hunters asked an interrogatory, Interrogatory No. 18, which asks some very general questions about techniques which are available to predict erosional losses and documentation of what is done on a site; is that correct?

A. That's correct.

MR. FREIDIN: And, Mr. Chairman, I would like to file that particular interrogatory as the next

exhibit.

THE CHAIRMAN: 462.

---<u>EXHIBIT NO. 462</u>: Interrogatory No. 18 of OFAH to Panel 11.

MR. GREENWOOD: I might just add, Mr. Freidin, you asked me about the concern for erosion. I restricted my remarks to the forest estate which my evidence was on. I think we heard yesterday about the obvious concern for significant erosion in terms of its effect on sedimentation or turbidity of watercourses, and this is something that you would have to keep in mind as well.

MR. FREIDIN: Q. Now, your evidence has been directed -- focused primarily at the forest estate?

MR. GREENWOOD: A. Yes. My concern in terms of this evidence would be for productivity of the site.

Q. Okay, thank you.

MR. FREIDIN: Mr. Chairman, I am going to move on to the area of micro-climate and it is going to take well past the break, I believe. This might be a convenient time for a break.

THE CHAIRMAN: Very well. We will break for 20 minutes. Thank you.

---Recess taken at 10:25 a.m.

---Upon resuming at 10:50 a.m.

THE CHAIRMAN: Thank you. Be seated.

MR. FREIDIN: Mr. Chairman, I would just like to advise that it is my information that there is a meeting scheduled for noon to deal with this clearcut methodology, and I believe that some of the counsel present were hoping to attend that meeting. So I would just like to indicate that I will be asking that we break at noon as opposed to the usual 12:30.

THE CHAIRMAN: We are not invited, I take it?

MR. FREIDIN: I have nothing do with it, Mr. Chairman.

THE CHAIRMAN: Okay. We will break at noon. And what are you suggesting, that we break until what, two o'clock?

MS. SWENARCHUK: Two o'clock.

THE CHAIRMAN: Okay.

MR. FREIDIN: I think so. I have just been looking at what is happening here, I think that we will probably finish Mr. Greenwood 3:30.

THE CHAIRMAN: 3:30?

MR. FREIDIN: Three or 3:30, somewhere around there. We will probably get a start on Mr.

Clark and a good chance of completing Mr. Clark tomorrow by noon, by the lunch break.

THE CHAIRMAN: Okay.

MR. FREIDIN: Okay.

Q. So, if I can move on to the subject of micro-climate which is one of the areas that you indicated that you wanted to speak about.

MR. FREIDIN: And, Mr. Chairman, Mr. Armson did touch on this by way of example, but I feel that it is important to sort of discuss this particular topic as one package, so I apologize if there may be some repetition or reference to Mr. Armson, but it will be brief.

Q. Mr. Greenwood, what is micro-climate?

MR. GREENWOOD: A. Well, for the purposes of the evidence, I have just defined it as the climate from the forest floor surface to the canopy cover.

Q. And could you advise: What are the elements of that micro-climate?

A. There is a number of main elements. Obviously the first one that we would be concerned with within that area is temperature and for purposes of micro-climate the temperature is broken into two different temperatures, the surface temperature and the

air temperature.

And it is separated to distinguish the fact that the temperature can be quite different between the surface and even as much as a quarter metre above it. A good example of that I think would be walking on a sand beach and burning your feet, but you are not burning your knees. It can be quite dramatic, the solar radiation on the forest floor in terms of heating.

The second one would be the amount of light within that area, the third one would be wind or wind movement within the area defined, the humidity within that area, and the last one, in terms of the main elements, would be the amount of precipitation that hits the forest floor.

Q. Okay. And why are these particular elements important?

A. Well, the elements in combination which create micro-climate are important particularly in terms of the effect that they can have on a species' ability to regenerate and, again, within that early growth period when they would be fairly close to the ground, particularly as that growth rate could affect their ability to survive and compete after they have regenerated.

Q. Okay. Does harvest have any effect on that micro-climate?

A. Well, if it is defined as area from the surface to the canopy, obviously if you remove that canopy it can have an effect. It can change all of the factors depending on the degree to which you open the canopy.

Q. All right. Could you perhaps describe the micro-climate in a situation where -- or compare, I guess, the micro-climate in a situation where on the one hand you have a closed canopy, and where on the other hand you have opened the canopy?

A. Within a closed canopy, if you look at the first factor that we talked about, temperature both of the surface and the air, that canopy will moderate the changes in temperature that will take place. The daytime temperatures will be cooler in both cases due to the shading effect of the canopy and the nighttime temperatures would be warmer as a result of the canopy holding the warmer air in.

Also, within a closed canopy there would be reduced light, the same shading that reduces the temperature is reducing light.

In terms of wind, the forest floor, particularly in the area under the canopy, is protected

from large amounts of wind movement. The relative humidity would be higher under a closed canopy, moisture is retained, less is evaporated and less precipitation would in fact hit the forest floor as a result of the interception that takes place at the forest canopy and the evaporation from that canopy.

In terms of opening the canopy, it would again depend on the degree to which you open the canopy, but as you open the canopy and solar radiation can enter further down or what would have been below the canopy, you would raise the surface temperature, you would raise the air temperature, but at nighttime, because you don't have the protection of that canopy, the opposite effect would take place and, in fact, your nighttime temperatures would be much cooler.

Light is obviously increased with opening the stand, the ability for air movement to take place in the form of wind would be greater, humidity as a result of that wind movement would be less, and the precipitation hitting the floor would obviously increase if there isn't vegetation to intercept it.

Q. And what is the result of a change in the micro-climate in general terms?

A. Well, in general terms the overall effect would be to change the characteristics for

growth on that site, the characteristics of site which would affect growth.

Q. And in terms of opening the stand, would the change in that micro-climate vary with the degree of opening of the canopy?

A. Yes, it would.

Q. I am just wondering if you could take those particular elements of the micro-climate, Mr. Greenwood, and describe how those factors not only might change due to harvest - I think you have perhaps explained that already - but indicate how the particular changes could affect growth and perhaps by way of giving us examples of situations in the field?

A. Okay. In terms of surface temperature - and I have to keep emphasizing that this will relate to the degree of stand opening - but in terms of surface temperature we heard in Panel 9 about how the increased temperature that takes place following harvest can lead to increased rates of decomposition of the organic matter and, therefore, release of nutrients and this would have an effect on the ability or the growth rate that would take place on the site. That would be considered a positive effect of change in micro-climate.

Another positive effect -- or an example

of a positive effect of increased surface temperatures would be the ability of those temperatures to open serotinous cones. Mr. Oldford described one of the methods of natural regeneration of jack pine would be to leave slash throughout the site. That can only be effective if both the surface and the air temperature is high enough that those cones will open with the heat. So, again, another positive effect.

In terms of a potential negative effect of increased surface temperature, this temperature could in fact dry out the litter layer and what may have been an appropriate seedbed while it was shaded would no longer be an appropriate seedbed for renewal of some species because of this dry litter layer.

In air temperature, I think I mentioned or I would have already said, that we are talking about extremes. If in fact those colder temperatures that we referred to create an ability for frost to settle on a site, you could have a negative effect for some species. Again, I think Mr. Armson referred to white spruce and its inability to -- or its susceptibility to late spring frosts.

At the same time, the warmer temperatures during the day can be important for seedling growth after renewal has taken place and this surface

temperature -- sorry, the air temperature, again, effect on jack pine cones.

An obvious example of an effect of increasing light would be the ability of intolerant species to regenerate. Jack pine/poplar would not regenerate in the shade of a canopy and by opening the stand you are creating a positive benefit in lieu of those species.

When I mentioned wind, I talked about its ability to decrease humidity. That could be a negative effect if it adds to drying the site out for some species. It could in fact, if it is severe enough, dessicate or dry out young regenerating forest vegetation and, therefore, limit its ability to establish. And in terms of humidity itself, it would decrease in relation to the amount of stand opening and that also could affect the ability of the site to dry out.

The last measure of micro-climate, the amount of precipitation hitting the floor. Again, we heard in Panel 9 how it is not only the increased temperature but the increased moisture that is in the forest floor that will increase the rate of decomposition and, therefore, releases nutrients. So the increase in precipitation or soil moisture can have

a positive effect and obviously increased precipitation hitting the floor and, therefore, being held in soil moisture can affect the ability of the trees to grow or their growth rate.

Q. So these changes in micro-climate then have potential to be positive or negative depending on the particular site that you are dealing with?

A. That's correct, site and species.

MR. FREIDIN: If I can just have a moment, Mr. Chairman.

Q. Could you provide perhaps just a few more examples about how knowledge about micro-climate could affect decisions regarding harvest?

A. I think in most of the positive effects and negative effects that I referred to it was fairly obvious that we are talking more about renewal of the site or at least we are centering on the topic of renewal of the site, so I would use some examples of that.

I have referred to the jack pine slash being opened by the increased temperatures. Knowing that jack pine is an intolerant species and requires full light, and knowing that the cones are serotinous, this would lead you to in fact prescribe a clearcut for

the area which would provide the light that is appropriate for renewal and you might also -- you would have to prescribe the tree-length logging method to distribute the slash across the site to take advantage of the increased temperatures and opening the cones.

Q. So in that particular example then the logging method and the harvest system would be chosen based on an understanding of how micro-climate might be changed?

A. That's correct.

Q. Okay. Can you give me another example?

A. Another example would be knowing that upland black spruce requires, if you were using natural regeneration, a seedbed of moist spagnum moss and that if you opened the stand completely you could increase the temperature and wind movement to the point that that seedbed could dry out and no longer be appropriate. However, you would also have to consider the fact that black spruce requires, for appropriate renewal rates, increased light even though they are semi-intolerant -- semi-tolerant they grow better in full light.

So knowing these various factors you would prescribe probably strip cuts which would modify

the micro-climate on the site to the point that the seedbed would not dry out by providing increased shading as opposed to opening the site completely reducing the wind movement which could cause dessication of that seedbed and you would determine the width of that strip, I think depending on the degree with which you wanted to affect that micro-climate.

Q. Mr. Hynard -- and those examples that you chose were sort of boreal forest region examples.

A. That is correct.

Q. And, Mr. Hynard, could you based on your experience in the Great Lakes/St. Lawrence region, perhaps provide an example or two about how knowledge regarding micro-climate can affect decisions regarding harvest?

MR. HYNARD: A. Yes. I think of the example of the use of the shelterwood harvest system to reduce the drying effects of sun and wind in the regeneration of species that are vulnerable to seedling dessication. White pine and yellow birch are good examples. Those seedlings like to have a little bit of protection from those drying effects during their first year.

Q. And what sort of harvest prescription would you -- might you adopt in order to address that

concern?

A. Well, let's take the example of the white pine. If you were relying upon a natural regeneration method you would -- you may select the use every uniform shelterwood, in which case those drying effects of sun and wind are reduced on the natural fresh germinates that are regenerating.

If, on the other hand, you were regenerating by artificial means for other reasons, same species, you might not select that harvest system because those effects are not important in the use of nursery -- bareroot nursiey stock.

Q. Mr. Greenwood, could you turn to page 254 of the witness statement, please.

MR. GREENWOOD: A. Yes, I have it.

Q. I refer you to the first full paragraph.

MR. FREIDIN: Page 254.

Q. The first full paragraph states:

"Should micro-climate effects be
determined to be detrimental
to forest establishment or growth, they
can be PREVENTED, MINIMIZED or MITIGATED
through control of harvest layout,
harvest method, degree of

utilization, protection (e.g. winter cut) or establishment of ground vegetation and choice of regeneration species."

Firstly, are there any corrections that you would like to make to that paragraph?

MR. GREENWOOD: A. Yes. Harvest method should read harvest system.

Q. That is in the third line?

A. That's correct.

Q. There's a reference to establishment of ground vegetation playing a role on the effect that a change of micro-climate might cause. Could you perhaps give me an example of how the establishment of ground vegetation could play such a role?

A. Yes. I would go back to the white spruce susceptibility to late frosts. One of the ways that you could affect micro-climate in a way that would reduce or minimize this effect, would be to maintain the vegetation on the site which in fact could moderate - similar to what the canopy had done before it was removed - the extremes in temperature that the white spruce would be exposed to.

Q. And could you provide an example of how the choice of species to be regenerated could address potential effects of micro-climate?

A. Yes. Again in the white spruce example, if the area was particular susceptible to forst and you weren't able to affect that, you could move to black spruce as a species which is not as susceptible to those late spring frosts because they flush at a later date.

Q. I think the question probably would have been more correctly the potential effects of a change in micro-climate.

A. That's right.

Q. Moving on for a very brief discussion of insect and disease sanitation which is the subject of a section on page 254 and 255, what are you referring to when you are talking about insect and disease sanitation?

A. Very simply it is the ability of harvest to afford some degree of insect disease and control.

Q. It is the control of insects and disease?

A. Correct.

Q. Could you provide an example of how, or when harvest might take place in order to control insects and disease?

A. One of the ones which has been more

prevalent in the area of the undertaking over the last little while is the acceleration of harvest of white spruce and balsam fir to limit the spread of the spruce budworm which was in a severe outbreak within the area of the undertaking -- well, has been now for over ten years.

Q. And why would you accelerate the harvest of those species?

A. Well, two reasons: In terms of control of the insect you are removing a source of food and a source -- and a habitat for breeding. I guess the second reason would be that you are attempting to utilize those species before the insect harvests it.

Q. Okay. And is there any other example that you could give of harvest being used as a means of controlling or limiting insect and disease?

A. Another example that I am familiar with personally is the clearing or removal through clearcutting of certain trees, diseased trees particularly in the vicinity of high value stands such as seed orchards or in the vicinity of areas such as nurseries, where the disease that is in those trees is one which could in fact move into the younger trees or the higher value trees and spread within them.

Q. Okay. Mr. Hynard, is there anything

that you could add perhaps by way of example from the Great Lakes/St. Lawrence?

MR. HYNARD: A. I can't think of an example in which you would actually -- where your harvest would actually sanitize a stand. I think you would almost have to boil your trees for 20 minutes to get that effect.

But I think of similar cases where we have made intentional harvest allocation of stands, particularly red oak, that were showing signs of tree decline. I think the main purpose there is not to confine tree decline, but rather to capture that wood before it was lost.

But in the selection harvest system, the integration of the harvest with tending to reduce the number of defective trees in the stand at the same time the harvest is being carried out is an example of some degree of sanitation.

Q. Okay, thank you. The last area that you indicated that you were going to address, Mr. Greenwood, is the area of forest diversity. And I believe that discussion begins on page 255 of the witness statement and carries through to the end pretty well. Could you begin by telling us what you mean by forest diversity?

MR. GREENWOOD: A. When I use the term I simply meant it to mean the diversity or the variability that is in the forest.

Q. And when you talk about diversity or variability within the forest, are you going to be addressing certain types of diversity?

A. Yes. I broke the subject area into three separate topics: Species diversity, age diversity, and genetic diversity as three areas that in fact harvest could have a potential impact on.

Q. Now, your paper makes a distinction between diversity in relation to those three things; species, age, and genetics within a stand and as between stands?

A. Correct.

Q. Could you perhaps explain to the Board what it is you are really talking about when you make that distinction?

A. Well, I have decided, Mr. Freidin, to use a flip chart for this because of some of the fun we had trying to explain it to you. So I am going to attempt to show it in a clear way.

Q. You mean I am going to understand it when you finish.

THE CHAIRMAN: That is making some

assumptions that may not altogether be true, Mr. Greenwood.

MR. GREENWOOD: Yes. I also do not draw very well, so I will have to do this somewhat schematically.

What I thought I would do to try and put our arms around this one would be to first of all conceptionally walk you into a stand and just point out some of the things that you might see in terms of diversity as you went. And if in fact we were parked on the side of a road looking at a stand, one of the things that you would see is that in the canopy there is different shapes and, in fact, these shapes would reflect different species and, therefore, within that stand you could see diversity in species.

Another thing that when you walk into the stand you might see is that when you look at one particular species there is variability within that species in its form and you might see that some of the stems are in fact curved or rippled, some of the stems are fairly large in diameter, others are small in diameter.

You might see that some particular trees within that species all have very sharp branch angles, an upward angle, others are perpendicular to the stem.

And what you are in fact seeing are differences that in fact can reflect genetic diversity within that stand. The different growth rates, different shapes of stems, branch angles are things which are fairly heavily controlled by the genetic variability within that stand.

MR. FREIDIN: Q. I understand that later on we will come back to that comment where you say the differences can reflect genetics, I understand later you will be explaining that in fact what you are seeing might not necessarily be the result of genetics?

A. That's correct.

Q. Okay.

A. Another thing that you see in this stand, you are going to see is that there are trees also in the understorey, they may be the same species. In this particular case I am in the boreal forest and they are probably not the same species because they would be tolerant and the canopy species would be intolerant.

These species generally are advanced growth which has come into the stand and, therefore, you are seeing a manifestation of age diversity within this stand. So in fact within the same stand we are seeing diversity of species, diversity of ages, and

indications that there is genetic diversity within the species that are there.

Now, if we were to get into a truck and start moving down the road and checking stands as we go, it is quite possible that we would see some of the same species in slightly different arrangements. We might see the same species as was in this mixed stand but all in a pure stand and, therefore, a stand where there isn't a species diversity now within the same stand.

You might -- this stand, in this case, is much smaller than the other stand, the site type isn't that different and, therefore, you would infer that this is a much younger stand. So now we have created age diversity between the stands.

You do notice, however, that the same characteristics of individual stems were also in this stand in that the variability in stem form; that is, some crooked, some rippled, some straight, is also within the species in the smaller stands; some are crooked, some are rippled, some are straight. This would be a rather distinct boundary in terms of creating diversity between the stand but in itself it is another stand and can have varying levels of diversity within it.

As you go further you may find a canopy which is the same size as those which were in the original stand we went to, still has diversity, but the species mixture changes slightly and where there was a heavy component of blue trees here, now the heavier component is to the red trees.

So in this case there is still species diversity within the stand just that the species have changed. And in this particular stand you also notice the same factors that could be controlled by genetics are there. In this particular stand, we also may have an understorey so, therefore, within the stand we have age diversity again.

So you are noting as you are going down the road that there are differences as you go past three stands not only in the diversity in those three factors that exist within each stand, but the diversity that exists between the stands.

The last part of the trip, if we were to lift off the ground now in a helicopter and look at this from above, you would see in fact that the spacial distribution of this -- of these species is repeated throughout the whole area and, in fact, a mosaic is formed of the differences between stands recognizing that still there are difference within stands.

And that might be reflected particularly on an FRI map by the fact that this was a poplar stand, with 80 per cent poplar; jack pine 20 per cent; species diversity, but as we cross along line here where we have poplar 100 per cent there is also diversity and a very sharp edge between those, but the change here was to jack pine 60 per cent; poplar 40 per cent and, therefore, even though both of these stands have mixed species diversity and, therefore, the edge isn't very sharp, there is a change in species and, therefore, diversity created between the stands.

The same thing with age, where this may be 30 years; both of these stands may be 80 years and, therefore, while you have age diversity within these stands you have very little age diversity between them but you do have a sharp age diversity between these.

MR. FREIDIN: Q. Perhaps you could just write a number 1 below the first stand that you described and draw lines down below the stands -- just put a number 1 below the stands which you described first right at the top, and 2 and 3.

Mr. Chairman, perhaps we could mark that as an exhibit.

THE CHAIRMAN: 463.

MR. FREIDIN: And my preference is to

title it: Diagram depicting forest diversity.

---<u>EXHIBIT NO. 463</u>: Hand-drawn diagram depicting forest diversity.

MR. FREIDIN: Q. Now, in that particular drawing, Mr. Greenwood, am I correct that in terms of genetic diversity or genetic variability that what you have shown is a situation where genetic variability is not different when you compare the genetic variability within the stand to genetic variability sort of at the forest level?

MR. GREENWOOD: A. That's correct. Whereas the factors of species and age could vary both within and between stands, the variability in what is indicated as genetics is the same both within and across or between the stands.

Q. And could you advise: Is there any significance to this observation that genetic variability is not different when you compared the variability within a stand to the genetic variability as between stands?

A. Yes. It is important in terms of the effects that harvest could have on genetics in that because the variability is the same over a much larger area, an area that we define as a population, if in fact you are harvesting at the stand level you aren't

affecting the variability at the population level.

Q. Now, throughout your evidence we are going to be talking about the differences of diversity I suppose in relation to age, species and genetics at the stand level and at the forest level?

A. Correct.

Q. And in the diagram that you have prepared up here you have simplified that and you have shown three different stands.

In a very general way, what do you mean when you use the term at the forest level when you are making this comparison -- diversity within a stand as compared to diversity at the forest level?

A. I do use the term throughout the evidence quite frequently. In my mind I was thinking that the forest is the area which is normally managed and, as such, it could equate to a management unit. It could equate to larger than a management unit as well, but for purposes of this evidence it is probably easier to think of it as that area for which management objectives are set and, therefore, the management unit.

Q. Okay. What is the purpose of your addressing this diversity?

A. The area that I addressed it under are in fact the three important elements in the forest,

the diversity of which can be affected by harvest.

Q. Is there any particular significance to this diversity?

A. Yes, there is. It's a generally accepted principle that the more diverse the forest or its organization, the greater that a variety of benefits that can be produced from it.

It also reflects its ability to adapt and survive under future environmental change, therefore, this diversity is important for that, at the forest level, for the forest to adapt and change.

Q. And when you say the ability to adapt to changes in the future, would you be including in that not only anticipated changes in the environment but unanticipated changes?

A. I would probably emphasize the unanticipated changes.

Q. Is this general or overall principle or concept to diversity always true?

A. Well, I think it is always true at the broad sense at the forest level or in a general sense, but there is always specific species of wildlife or plants or even segments of society which either would prefer or even require that the diversity be limited, particularly at the local level.

If I might give an example. In terms of a species of wildlife there is a small warbler called the Kirtland's warbler which requires for its nesting habit a very specific habitat, it's young regenerating jack pine, relatively open and on a drier site because they nest on the ground. So in the case of the Kirtland's warbler they require a very specific habitat and in fact to satisfy their needs need that diversity limited.

Another example would be a mill that can only utilize jack pine. It may be that the most beneficial diversity for that mill would be one limited to only a jack pine forest.

And even a third example would maybe be a recreationalist that only prefers to recreate in older forests, so for that person their objective would be to have older forests.

Q. Okay. So basically forest diversity can be seen as positive by some people or be positive for some species of wildlife or plant but, on the other hand, be viewed -- the same situation be viewed as negative by others depending on what are their particular objectives or needs might be from the forest?

A. That is correct.

Q. Referring to your paper, Mr. Greenwood, in terms of forest diversity - and I am now talking to all three kinds of diversity that you have mentioned, the three aspects of forest diversity - was it your intention to address the positive or the negative aspects of forest diversity in terms of a particular objective for the forest?

A. No, it was not. I specifically was trying to look at it in the sense that limiting diversity to meet specific needs or objectives, certain products or even values is necessary but that that should be done in the context of maintaining diversity at that broader level.

Q. If management objectives result in the conscious limiting of diversity at the stand level, is it contradictory to say that this limitation of diversity should occur within the context of forest diversity in the broader sense is important?

A. No, I don't think it is. And I think that there is three things that can be considered here that might help explain that.

If I use natural disturbance as the benchmark, the diversity can change at any point in time following natural disturbance at the local level. If a fire comes through, it can alter the disturbance

at the stand level as we've described it, but because fire doesn't occur everywhere at the same time and in the same way, diversity at the forest level is still maintained.

And harvest, in some respects, is comparable to the natural disturbance in this sense, in that it doesn't take place everywhere at the same time throughout the whole area of the undertaking and, therefore, it can affect diversity at the stand level but still maintain diversity at the forest level.

Foresters in consultation with wildlife and fisheries biologists can utilize this concept to meet the objectives of providing forest products, at the same time as providing the benefits of diversity in the larger sense.

So I think that is really the first major factor that I would consider in looking at our ability to achieve this and, in fact, I think you can look at it as shuffling the deck but not changing the deck. Forest management can alter where the cards are in the deck, but still maintains the deck.

MR. FREIDIN: I am sure that analogy will probably get us into discussions similar to the game of checkers, Mr. Chairman. It will be interesting to see what the analogies are.

MR. GREENWOOD: Now, a second consideration that I would like to explain is the fact that timber management only takes place on part of the land base. There are still parks and reserves and withdrawn areas that are not affected by timber management and the significance of this fact is that nature will take its course on these sites and, therefore, the diversity which would normally be created by nature will still be created in these areas.

And likewise, natural disturbances still take place on a significant portion of the area of the undertaking and still, therefore, have significant effects on the diversity that is formed at the forest level and the randomness that is created through natural disturbance as opposed to harvest.

MR. FREIDIN: Q. I would like to deal with each of the three types of diversity, one at a time.

But before we begin, when you refer to the effect of harvest on species diversity, age diversity and genetic diversity, are you making any assumptions regarding the manner in which regeneration occurs after harvest?

A. Yes, I am. I have limited the discussion here to regeneration through natural means.

Regeneration through artificial means and its effect on diversity at these three levels is discussed in Panel 11.

Q. Okay. So if we could begin then by dealing with species diversity, and the walk you took the Board through a moment ago in that drawing, Exhibit 463, you referred to species diversity within a stand and you pointed out the diversity between stands. And could you explain how this diversity was created through natural forces?

A. It's really, if you were to simplify it, created through three factors at the stand level. The first would be disturbance and its type, severity and frequency at that level, and that can range from one tree falling over in the Great Lakes-St. Lawrence Forest and an advanced growth seedling taking its place, right through to the effects of fire.

The second thing -- second factor that would determine what came back would be the site itself and the fact that some species are more readily available to regenerate and survive and compete on some sites.

So the soil characteristics, the aspect, the local climate would all be factors of site which would determine the diversity, in effect, those stands.

The last significant factor would be the reproductive sources that are in fact at play on the site whether it be roots or advanced growth or seed.

Q. Okay. What role could harvest play in species diversity?

A. In terms of the three factors I just described, it plays the disturbance factor and in combination with those other two factors, site and reproductive forces, would determine the future diversity of the stand.

Q. Okay. Now, when we are discussing species diversity, in this context is there any difference between a disturbance by nature -- natural disturbance in comparison to disturbance through harvest?

A. When one considers all of the natural disturbances there would be very little difference, but if one looks at the majority of the area of the undertaking which has been regenerated by fire, I think there are two differences there worth noting.

And one would be that harvest can remove the reproductive sources from the site, particularly I am referring to seed here, where fire would not do that.

The second one would be that harvest in

some circumstances -- in fact in many circumstances, would be less of a site disturbance than fire and, therefore, there isn't as much mineral soil exposure and it also wouldn't remove advanced growth and this could obviously affect future diversity, in that if fire burnt all of the advanced growth, then -- and harvest didn't, there would be a difference in diversity or difference in species following the two disturbances.

Q. You indicated in that answer that harvest could affect, I guess, the reproduction sources by removal of a source of seed. Is that something which automatically happens after each harvest, or is that something which could occur as a result of the harvest?

A. No, it could occur.

Q. In what ways could harvest followed by natural regeneration affect species diversity within a stand?

A. Like natural disturbance, it could increase or decrease or maintain the species diversity.

Q. Could you give me an example of each of those situations where you could maintain or increase or decrease species diversity as a result of harvest?

A. Yes, I can. And, again, I would like to emphasize that that is dealing with only natural regeneration following harvest, not the effects of artificial renewal.

In the first example, if it was a pure poplar stand which was clearcut, the natural suckering -- root suckering of that poplar would in fact regenerate the stand and create a new poplar stand with the same species diversity as the original, and I am assuming here a pure poplar stand. So in this respect, clearcut has maintained diversity of the stand.

In a second example, if the poplar stand now had a jack pine component and was growing on a fresher site, a site with a little bit more moisture than a dry jack pine site and only the jack pipe is removed from that site, the reduction in the jack pine seed source and the prolific root suckering of the poplar on that site would in fact, in most cases, create a pure poplar stand coming back. If there was a jack pine component it would be very slight.

And, in this case, due to the factors of site and reproductive sources and the way the harvest was carried out, you could decrease species diversity within that stand.

If we use the same stand however and there is an understorey, such as the one that I drew in area No. 1 or stand No. 1 of either balsam fir or black spruce or both and you removed just the jack pine, there would still be some poplar suckering, but that advanced growth would have quite a jump, so to speak, on the poplar suckering and would, in fact - if the stand was opened enough - form a component in the new stand. And, in this sense, although the species jack pine is being replaced by balsam fir and black spruce, you are still maintaining diversity.

So on the same site as the previous example, you are now maintaining diversity where the previous one decreased it, just depending on somewhat richness of the site and the condition of advanced growth.

Q. I'm just wondering, have you given an example yet of increase in diversity?

A. Yes. An example of increase in diversity would be a pure jack pine stand on a fairly dry clearcut site or a site clearcut in the summer - and I say that because a clearcut in summer would create some degree of mineral soil exposure - but in this example the jack pine site, if it is surrounded in poplar or if there is any poplar at all component in

that stand, you will get invasion of poplar on to the site. With some seed source remaining from that jack pine and some mineral soil exposure you will get a component of jack pine regenerating on the site as well.

In this instance, the pure jack pine site or stand could be replaced by a mixed jack pine/poplar stand and would in fact reflect an increase in species diversity at the stand level.

Q. Does an understanding of species diversity and in particular how disturbance can affect it, have any significance for timber management?

A. Yes, it does. Knowing what will occur naturally on those sites through, for example, those examples I just gave, you would know what the future stand would look like and this would, of course, relate to ability to know species/site relationships.

And knowing what the future site would look like, examined against the timber and non-timber values for the area, would allow you to make informed silvicultural decisions for that site. And I am thinking of an example where knowing what would come back naturally and taking into account objectives, one may make the decision to artificially regenerate the site as opposed to allow the natural regeneration to

take place.

Q. Can you advise, Mr. Greenwood, whether this knowledge and these objectives that you have just referred would be reflected in a timber management plan?

A. Yes, they would be reflected in Table 4.11, the silvicultural ground rules of a timber management plan.

Q. And I think -- I didn't ask or advise the Board to bring their copy of that, nor did I advise the other parties. Perhaps we will just leave that, we will come back to that after lunch and we will deal with where in fact you might see that in a timber management plan.

Now, what effect do these changes in terms of species diversity at the stand level have on species diversity at the forest level?

A. Well, the effect is that even if you change the species at the stand level through harvest there is a number of factors, in fact there is four factors that I could describe, operating within the forest that would still create species diversity at the forest level.

The first would be that harvesting is dispersed in space and time throughout the forest and,

therefore, you are only affecting species diversity in small patches throughout the forest at one point in time. This relates to the shuffling of the deck.

A second point would be that the choice of harvesting system, including harvesting intensity and logging method, varies and each of these can influence the new forest which regenerates and would influence it to varying degrees throughout the forest.

And probably one of the most key factors is the fact that site varies throughout the area of the undertaking and site is a very strong influence on what will regenerate on that area. And, in some cases, at its extremes, there is only one tree species which will grow within the limiting factors of the site and, therefore, will maintain diversity.

Q. Can you just give me an example. You must have some particular example in your mind when you say that?

A. Sure. If you look at moisture regimes of sites, they range from very wet right through to very dry and in the middle you have these fresh and moist sites that I referred to once or twice.

In those fresh and moist sites almost anything will grow, and particularly those sites tend to be related to nutrient richness as well and almost

any species will grow there and, in fact, many species usually do grow there in a mixture.

As you move to the extremes in terms of the rigors of the site, either very wet or very dry, a number of species which can survive and grow there becomes very limited and at the extremes, at the very dry sites in the area of the undertaking, really the only species which grows there effectively is jack pine. And in the very wet sites the only species that survives and grows there effectively is black spruce in terms of forest species.

Q. Okay.

A. A fourth point that I didn't get to and that's the fact that natural disturbance is still taking place across the forest and it is followed by natural regeneration in most cases and is significant and, therefore, can affect species diversity at the forest level.

So I guess the point of these four factors is that when you combine the different effects of harvest at the stand level and those other effects of site and natural disturbance, the mosaic of new stands which is created is in fact similar in terms of complexity to the original forest and, therefore, diversity in terms of species is maintained across the

forest.

Q. Is this change in species diversity positive or negative?

A. I think I have tried to distinguish between the stand level and the forest level and it would depend on whether you are examining it at the stand level or the forest level.

Q. Can you explain why there would be a difference depending on which level you were looking at it?

A. Well, if you affect species at the stand level but are not affecting the mosaic or diversity across the whole area of the undertaking or the forest level in particular, you can only evaluate, in my mind, whether that has been a positive or negative effect when you take into account the objectives for management at the stand level and whether you have obtained those management objectives at that stand level.

Q. Can you give me an example of where a change in species diversity of a stand brought about because of harvest could be positive or negative depending upon management objectives?

A. If I go back to the poplar/jack pine stand which is a mixed stand and harvest only the

conifer and it regenerates as I suggested the first time to pure poplar, harvest in this sense has reduced species diversity at that stand level. And if your timber management objective was to supply conifer and there was no market for poplar, then in fact that reduction in species diversity could be negative in terms of that timber management objective.

On the other hand, if in fact the creation of this young poplar within that stand through suckering is within a stand where in adjacent stands there is conifer content, particularly conifer content that might be suitable for habitat for moose, then you may have created an optimal situation where there is ample browse next to habitat or cover and, therefore, have created a positive effect in terms of a wildlife objective.

Q. Let's just change the hypothetical a bit and let's say that there was a poplar market in that same situation, either existing or being contemplated in the very near future for poplar from that particular area; would the situation change?

A. In that respect the change in species diversity would be positive for both objectives.

Q. Okay. And, Dr. Euler, do wildlife managers have any input into decisions which are made

within timber management which can affect species diversity?

DR. EULER: A. Yes, they do. They are usually part of the planning process and they would have in the back of their minds the various objectives that they are working towards, and one of the goals that they would often be working towards is increasing the diversity of the plant communities there.

Q. And I understand we will probably be dealing with that in much more detail after the break?

A. Yes, I believe so.

Q. Okay. Just dealing with the second level or the broader level, species diversity at the forest level, would a reduction in species diversity or changes in species diversity be positive or negative at the forest level?

MR. GREENWOOD: A. If it was in fact a reduction in species diversity, I would consider it a negative.

Q. Okay.

MR. FREIDIN: Mr. Chairman, that's a convenient place to break. I am going to move on into age diversity, so if we can break then and I understand until two o'clock?

THE CHAIRMAN: That's correct, we'll

adjourn until two o'clock.

MR. FREIDIN: Thank you.

THE CHAIRMAN: Thank you.

---Luncheon recess taken at 11:55 p.m.

---Upon resuming at 2:00 p.m.

THE CHAIRMAN: Thank you, be seated.

MR. FREIDIN: Q. Just a couple of questions of clarification before we get on to age diversity.

Dr. Euler, this morning Mr. Greenwood dealt with the effect that having objectives for particular species of wildlife or a segment of society could result in a particular species wanting a limited diversity as opposed to diversity in terms of just generally in the forest.

And I think he used an example of a species of wildlife or plant that might require specific needs in terms of diversity. He used the example of a Kirtland's warbler, is that the right way...?

DR. EULER: A. Yes.

Q. Now, I understand that you just wanted to make a brief comment in relation to that example?

A. Well, a Kirtland's warbler is a

perfectly good example of that phenomenon, however, we don't have any of those birds in Ontario that nest here and there are, however, a number of animals that illustrate that principle that do live in Ontario.

A spruce grouse is another good example, rough grouse is another good example of species that don't require diversity as much as they do a certain fairly uniform type of habitat.

Q. Okay. Mr. Greenwood, if I can go back to the evidence you gave right almost at the outset of species diversity. You were describing the differences between harvest and natural disturbance in relation to the subject matter of species diversity.

And I understand that you want to go back and just make a couple of comments to ensure that there was no misunderstanding or perhaps unintentional misinterpretation of the message you were trying to convey?

MR. GREENWOOD: A. Yes, it was just to clarify a couple of comments that I did make or I think I made. It may have been said that wild fire wouldn't remove the seed source where harvest would, and the assumption I was making there was that wild fire wouldn't normally remove the seed source.

There are certainly circumstances where

wood - in fact I can think of two - if wild fire went through a young fire regenerated jack pine stand which wasn't old enough to be producing a cone crop yet or just young enough that the cones were just starting to form, it could in fact remove the cone crop the same as harvest would.

A second one I think that I also referred to was wild fire potentially creating more disturbance than harvest and I think the reference was to the forest floor. And, again, this is often the case, but I would qualify it by saying that it would very much depend on, if you were making this type of comparison, the season of harvest, the type of logging method that was used and, in terms of the fire, the severity of the fire.

Q. And in terms of the exposure of mineral soil due to the disturbance of harvest as opposed to fire, how would you compare the two disturbances?

A. In much the same way, that it would depend on the severity of the fire and the season of harvest. Fire would always affect the forest floor in that it would always consume some of it, but it would very much -- whether it exposed mineral soil, would very much depend on the severity of the fire and the

thickness of the forest floor. In terms of harvest the same thing would be true, it would depend on the thickness of the forest floor and, in fact, the season of harvest in this case.

Q. Okay. And we had a section in species diversity where you were going to refer to the timber management planning manual. I was asking you whether an understanding of species diversity and, in particular, how disturbance can affect it had any significance for timber management.

And you said, basically knowing what would occur naturally in terms of regeneration and what species were likely to come back, foresters could use that understanding and that knowledge to in fact make silvicultural decisions.

A. Correct.

Q. Particularly if they wanted to change what was going to come back. And you had indicated that the timber management planning manual did have a table in it which would indicate or manifest where this type of knowledge might be reflected, and I think it was Table 4.11 in Exhibit No. 7?

A. That's correct.

Q. And could you indicate what portion of that particular table that you are referring to?

A. I am referring to three columns in particular in this table which has been discussed before.

Q. Just one moment, Mr. Greenwood.

MR. FREIDIN: Mr. Chairman, I can give you a copy of our exhibit, of the Timber Management Planning Manual. (handed)

THE CHAIRMAN: Thank you very much. Sorry, what page again?

MR. FREIDIN: I think it is at page...

MR. GREENWOOD: 65.

MR. FREIDIN: 65, yes.

Q. All right. You said that you were going to refer to three columns in that table?

MR. GREENWOOD: A. That's correct. The far left column which says FRI WG or FRI working group, two columns over which is PROP, proposed working group or forest unit, and under the heading Stocking Standards, the far right column, minimum to acceptable species.

Now, if in fact - and in this situation we were talking about natural regeneration - the forest manager had a working group in the left column such as poplar and the proposed working group was again poplar, that in itself -- and the renewal treatment was natural

regeneration, that in itself is a manifestation of that forester's knowledge that that site is naturally going to root sucker back to poplar.

If in fact it was poplar but there was an understorey of balsam fir or black spruce, you would probably see under the proposed working group that component forming part of the working group or forest unit in the proposed working group, or you would possibly see it reflected under the minimum to acceptable species in that the balsam fir and black spruce would be acceptable.

Q. And conversely, if you had a change from the working group which perhaps was poplar in the left-hand column and that you were proposing to in fact change the working group, would you see a reflection then again of that understanding?

A. Yes. If in the case where I think I said you might have a jack pine and poplar current FRI working group and the poplar could root sucker and the proposed working group would be poplar then, knowing that the silvicultural prescription may be for artificial regeneration, site preparation and artificial regeneration to keep the jack pine component in the stand, and then depending on intensity of that treatment your proposed working group could in fact be

again jack pine and poplar.

And it would be -- so the reflection of what would have happened on the site would result in the artificial regeneration treatment being applied.

Q. Okay, thank you.

MR. FREIDIN: Mr. Chairman, we'll be seeing an entire Table 4.11 when we deal with the timber management planning process in Panel 15.

THE CHAIRMAN: Do you need this back?

MR. FREIDIN: Sure.

THE CHAIRMAN: (handed)

MR. FREIDIN: Q. Okay. If we could move on then to age diversity. Does harvest have an effect on age diversity, Mr. Greenwood?

MR. GREENWOOD: A. Yes, it does.

Q. And can you describe what those effects are?

A. Well, harvest like natural disturbance, or at least harvest as a part of a silvicultural system is the first step in renewal and as such converts older stands into younger regenerating stands or is an important phase in that component.

In uneven-aged stands, as we have heard from Mr. Hynard, the selection harvest system can open the canopy and in fact allow for advanced growth or

regeneration as a result of light entering that forest.

I think in earlier evidence by Dr. Osborn in Panel 3 he described how many of the management units in the area of the undertaking have skewed age classes to the older -- or the age class distribution is skewed to the older age classes. And this fact combined with the fact that harvest is dispersed in nature compared to fire can create greater spacial age diversity throughout the area of the undertaking, particularly in the boreal forest, by distributing this age class difference over smaller areas.

Q. Now, as I recall the evidence of Dr. Osborn in describing objectives of timber management, he indicated that, at least at one portion, that the objective was to provide a continuous supply of wood to the forest products industry while at the same time attempting to manipulate the forest into a normal forest which would have equal age class distribution or an equal area in all age classes over time.

Now, if that objective of normal forest was achieved, what would that do for age classes represented within each working group?

A. Well, within the normal forest the age class is -- the area within each age class in the working group would be the same, therefore, if you are

starting with a forest which is skewed to the older age classes, you would create more area in those even-aged classes but because the normal forest assumes that all areas are harvested at rotation age, you could create those -- the area in the younger age classes at the expense of area in age classes above rotation age.

Q. In the normal forest you wouldn't have age classes which would be overmature when compared to rotation?

A. That is correct.

Q. Now, for the present working groups do you foresee the disappearance of these older age classes within the foreseeable future?

A. No, I don't. It is unlikely that it would occur in less than a rotation for most of the units or at least for many parts of area of the undertaking. However, that would vary by management unit, it would vary by species that you are examining throughout the area of the undertaking.

Q. Can you put any geographic bounds on where these management units might be the ones which in fact have a preponderance of overmature?

A. The preponderance of overmaturity is related to the degree to which we have been successful in protecting the forest from natural disturbance,

therefore -- and I would have to say in a very general sense, because I don't know that there is a trend where I could identify a geographical area.

But in areas where natural disturbance has played a larger role in regenerating the stands - and I think it is generally accepted for instance in the northwest fire incidence is higher in the northwest region than the northern region - I would expect that within that northwest region it would be a geographical area which would move towards the normal forest quicker than the northern region.

Q. Okay. You made a comment about that it was unlikely that you would foresee the disappearance of these older age classes, age classes beyond rotation for at least a rotation in many areas, as you say, depending on management unit and species that you were talking about. Could you explain the basis of that belief?

A. I think it's based in the understanding that the normal forest is a concept, it is a principle, it is a principle that allows us to manage in a way that ensures best utilization of the forest from a timber management perspective and, as such, it really is a theoretical state and almost impossible to attain at the forest level.

Now, there is three principal reasons why I would say that. The first is that it assumes that the entire maximum allowable depletion is in fact depleted, and yet we know that markets and accessibility and merchantability of stands that exist normally results in the maximum allowable depletion being at -- sorry, the actual depletion being less than that maximum.

The second reason would be that it assumes that cutting strictly follows the oldest first principle, you must be removing timber from those oldest age classes to move towards the normal forest. But again we know that accessibility and merchantability of many of these stands, particularly those which are already into a very old state, and the large preponderance of these older age classes now within the area of the undertaking makes this unrealistic in actual practice.

The other assumption within that statement would be that the managed forest would have to equal the total forest and, again, we know that parks and private lands and withdrawals and certain reserves don't form part of the managed forest and, therefore, undergo the natural processes of aging.

So for the normal forest to exist is

almost impossible, particularly over the whole forest within the undertaking.

Q. I would ask that you demonstrate basically what you have said, and I understand that to do that you want to refer to a number of histograms; is that correct?

A. That's correct.

Q. All right.

MR. FREIDIN: And perhaps I could provide copies (handed)

THE CHAIRMAN: How do you want these numbered, Mr. Freidin?

MR. FREIDIN: Well, there are four of them. I think we can just make them one exhibit, page 1, 2, 3, 4.

THE CHAIRMAN: All right. Exhibit 464.

---EXHIBIT NO. 464: Series of four histograms.

MR. FREIDIN: 464, Mr. Chairman?

THE CHAIRMAN: That's correct.

MR. GREENWOOD: At first glance this looks somewhat confusing, but I will explain how the table is put together, these histograms are put together and it should make more sense.

Across the bottom we have a series of age classes from the NSR Classes 2 to 4, so those areas

which have not entered free to grow yet, and free to grow to 20, 21-40, and so on up to 121 plus, and the 121 plus actually includes ages up to 150 in it.

These age classes are for an actual forest, Superior Forest in Chapleau District. They represent the spruce working group for that forest and the age classes were generated as a result of a run of AWOSFOP which generated the data necessary to put the age class distributions together at certain points in time into the future.

The solid black lines across the front are the current areas within each one of those age classes, so age class distribution of the current forest.

As you move back behind that first column you are going back 20 years in time with each step back towards the back of the histogram. So, for instance, 20 years into the future -- I should back up. Each step in time harvest takes place and the assumption in this case was that which - one of the conditions I mentioned a minute ago - a hundred per cent of the MAD, and one of the other factors that would affect age class distribution is that of regeneration.

Obviously if you are harvesting in one working unit or forest unit or working group but moving

that area into another, converting it to another species, it is not coming back in at the bottom end and you could skew your age class distribution so the average age is older. But it is not really an effect of actual -- of changes that would go on.

Now, in order for the normal forest to take place, what we are going to examine is the effect of a hundred per cent maximum allowable depletion taking place and you will notice that in this forest the oldest age class 121 plus exists for over 60 years into the future; 20, 40, 60 years we still have an area within this working group before it then drops to a younger age class and then this working group does not exist any more within -- and we move towards the normal forest.

Just a little easier way to see this. If you in fact are harvesting oldest first, you are harvesting where there still is area of age class distributions and this is the same thing just showing where each five year, the age of the five-year MAD and where it is coming from. So again you see that in fact it drops down to fairly young age class before it -- in the 81-100 year before it comes back after close to hundred years where all the harvesting is taking place at rotation age.

MR. FREIDIN: Q. So if we look at that -- we look at 121 plus, that oldest age class continues to exist for 80 years?

A. That's correct.

Q. And after -- and during those 80 years --

A. Within the hundred year run the age class of the oldest stands within this forest unit is now in the 81-100 year class and then the following 20-year period, 120 years from now it would still be in that age class before it comes back up to the 101-120 age class, the rotation age - I neglected to mention for this species is 110 years - so you are reaching, you are close to your normal -- or at least you are harvesting that rotation age only after 120 years of harvesting.

Q. Okay.

A. Now, the purpose of this was to he show how if you didn't harvest just full MAD, which was one of the three factors, how that could change what happens to your age class distribution.

So the next run was made where only 60 per cent of the MAD is harvested.

Q. And this is again for the Superior Forest and is spruce?

A. Same forest same data set up the same way in terms of runs into the future.

Q. Right. And the document that you are referring to is that part of the exhibit which is entitled Spruce B2.

A. That's correct. Now, because you are not harvesting the full MAD there are still areas in this older -- in these older age classes which remain. You are not removing all of that area and, therefore, moving into the younger age classes towards the rotation age which would take place when you reach the normal forest.

And in this case for the full extent of the run, 140 years, you still have area within the oldest age class in this particular model which might be 121-150 years, or in the case of where your harvesting is coming from, the age class of the stands from where your harvest is coming from --

Q. And now you are referring to the fourth page of this exhibit which is entitled Spruce B1?

A. It always takes place in the 121 plus age class. So just by reducing -- reflecting the fact that the full maximum allowable depletion was not taking place, you have created a forest where you are

always harvesting well above rotation and old age stands continue to exist.

If you combine just that one factor with the other two factors, in fact you would create a situation where there is even more forest in the 121-150 age class.

Q. And are there working groups in various management units which are being harvested at a rate less than a hundred per cent of the maximum allowable depletion for that working group?

A. Yes, there are.

Q. And I take it there are working groups of the various types where in fact, depending on management unit, you may be harvesting close to the MAD?

A. Yes.

Q. All right. And that basically goes to your comment earlier that the situation would vary by management unit and by working group?

A. That's correct.

Q. Okay.

A. In terms of the relationship, it would be almost a straight line relationship. If in fact you were harvesting 80 per cent, you would in fact maybe move towards normal; in the hundred per cent it

was after 80 years, it might be after 120, 140 years that you would get to normal.

Q. All other...

A. Or rotation ageI should say.

Q. All other variables remaining constant?

A. Correct.

Q. Genetic diversity, perhaps we can move on to that now. I understand that before we really get into this you would like to begin this discussion by describing certain basic concepts which you feel should be understood?

A. That's correct.

Q. And can you describe those concepts?

A. First of all, when we examine genetic diversity it can be discussed at three different levels: It can be discussed at the level of the individual tree, it can be discussed at the stand level or at the population level, but when you are doing so -- when you are discussing it at any one of those levels, there is three important concepts that you must keep in mind. And I don't intend to elaborate too much on these concepts, some of them will be the basis of evidence given in Panel 11.

The first one is that genetic variability

is necessary in a population, and that is as opposed to a tree or a stand, to ensure that that population can reproduce and maintain itself in a changing environment over time.

Q. Could you describe what you mean by a population?

A. Population. Well, a population, it would vary. What I mean by population would not vary but the actual geographical bound of it would vary by species. But in simple terms it is simply the area -- an area where interbreeding of individuals takes place.

Q. And is that a large area, a small area - and, again, I know I am asking you to generalize - but just to understand your evidence without getting into all the sort of scientific details of this, can you give some idea of what you are talking about in terms of area?

A. With our species in the area of the undertaking, the major ones we are looking at, it is a relatively large area in that our pollen can fly over 200 miles and, therefore, it can be fertilizing cones or female flowers that are a long distance away. So that population can be quite large.

Now, there are exceptions to that. If you had an area where -- of a particular species which

was separated by a particularly large distance from others of that species and that -- the area of that species where it was separated was quite small, it could form its own interbreeding population.

Maybe an example is the easiest way to explain that. When you move into the Clay Belt area, the presence of jack pine is reduced fairly dramatically and poplar and black spruce is very, very common.

North of Kapuskasing there is a pocket of soil that is appropriate for jack pine and there is a fair amount of jack pine in that area. That jack pine however is far enough away from other stands of jack pine that I would consider it a separate population of jack pine. It may or may not be, one would have to test, but for purposes of management, I would consider that a separate area.

The other thing with population, now that it has been opened, we tend to draw lines around a population for purposes of discussing it or managing but, in actual fact, a population wouldn't have -- wouldn't usually have strict boundaries. In the case of the isolated population it could have a fairly definite boundary, but in a species such as jack pine that ranges all the way from Newfoundland to Alberta

there is a lot of interbreeding all the way along.

In other words, there is a gradient and for purposes of management we would draw lines around areas and, in fact, there definitely throughout that area would be differences in the way the species would respond to various effects of the environment.

In fact Mr. Armson led or described briefly the clinal variation that latitude creates as one moves north, I think he used red maple. Red maple grows in Florida and grows at the northern end of the area of the undertaking. As you move throughout that clinal variation, that tree would have different habits of bud set and bud break that would be related to the environment that it is growing in and it would be difficult to draw lines and you wouldn't find a place where it flushed one week here and, as you crossed the line, it flushed the next week. There would be a gradient.

Q. Okay. And just to deal with that isolated population of jack pine near Kapuskasing, in the area that you are talking about would that be an area smaller than a management unit?

A. Yes, it would be. In most cases the populations that we are talking about would be larger than a management unit.

Q. Okay. Now, I think that is one of the three concepts that genetic variability is necessary in a population to ensure it can reproduce and maintain itself.

A. That's correct.

Q. What are the other two?

A. The second one that is important to understand - and I think it came up briefly - when I drew the drawing and talked about genetic diversity on the flip chart, I talked about -- you could see indications of the genetic makeup of those trees.

What we actually see is not the genetic makeup of the tree or its genotype, what we see is an interaction between the genotype and the environment that it has grown up in and the term that we use to describe that is its phenotype. In other words, there are genes controlling the way that tree is growing and how it looks, but the environment can also affect the way that tree looks and how it grew and that is what you see.

Now, given that there are certain characteristics of trees that we know are fairly strongly controlled by genetics and, therefore, when we see that particular form or characteristics we are relatively sure that what we are seeing is a

manifestation of the genetic makeup of that tree.

In jack pine, stem form is one, for instance

Q. All right. And the third concept?

A. The third concept is that genetic variability does change naturally, and probably one of the most visible examples of that would be the natural selection that takes place within the forest.

Mr. Hynard, when he was leading his evidence, made the comment that I think it was one stand was 13,000 stems per acre and that it would end up at maturity at about 400. Something is happening to those stems and that is the process of natural selection whereby they are competing with each other even though they are the same species and some will be winners and some will be losers. I think this is commonly referred to as survival of the fittest.

So in doing that, the genetic variability or diversity within the stand is in fact being reduced naturally in that the so-called losers are dropping out.

Q. What is the significance of these concepts in relation to harvest activities?

A. Probably the easiest way to do that is to gp back through them and talk about them from a

harvest perspective.

Q. All right.

A. The first one was the concept that genetic variability is necessary at the population level and the significance of that is that harvest which takes place at the stand level can affect genetic diversity at the stand level but that foresters would be concerned with maintaining the diversity at the population level. Therefore, even though you had an effect at the stand level, that may not be affecting the variability at all at the population level.

Q. Could you provide an example of how a concern by a forester about genetic variability in the population could be manifested?

A. I am not sure if evidence has been led about seed control zones yet, but one of the things that represents that type of concern would be the designation of areas within which seed must be collected and, particularly for the regeneration program, any regeneration which takes place must be utilizing seed from within that zone.

So it is an approximation of a population. If you are going to regenerate artificially within that area you must use seed which is collected from within that seed zone. We control

movement of seed therefore to within populations.

Q. Okay. Now --

A. Sorry.

Q. Go ahead. Could you deal with the second concept then?

A. The second concept related to the fact that what we are seeing is in fact phenotype as opposed to genotype or we are seeing characteristics which may or may not be a reflection of the genetic control that is taking place within that particular species.

The results of operations therefore, particularly those which might select for certain characteristics, may or may not be affecting the genetics; they would only be affecting genetic diversity if in fact those characteristics selected for were in fact characteristics -- were reflections of the genetic makeup of that individual.

In either case, if those -- if that area was regenerated from individuals which were genetically related to those removed there would still not even be an effect at the stand level.

Q. Okay. Mr. Hynard, would you be able to provide an example of where -- of the second concept in practice?

MR. HYNARD: A. When Mr. Greenwood was talking about variability between trees and genotypes and phenotypes, I was thinking about a tree marking. When we are marking trees for selection cutting or for commercial thinnings or improvement work, a tree marker is faced with decisions tree-by-tree. He is making choices about which trees to take and which trees to leave and, of course, he is forced to look at the variations in trees and all he knows about the tree is what he can see.

For example, if a tree has a crack and a seam and it is rotten inside, he can see that. Is that tree defective because it inherited that characteristically or is it defective because of bad luck, another tree fell on it when it was younger and the wound became infected. And that is the kind of thing that we see day-by-day and, of course, that tree marker isn't certain about that at all.

He marks that defective tree to be removed, not in order to improve the overall genetic makeup of the forest, but rather because he knows that rotten tree is just going to grow into a bigger rotten tree and that is all the logic he really needs, unless it has a value for some other purpose.

THE CHAIRMAN: Sounds like crime in the

forest.

MR. HYNARD: Anyway, if we continue to harvest trees in that fashion, continue to remove trees because they are slow-growing trees, low-vigor trees, defective trees, are we improving the genetic makeup of that forest in the long run. And I believe that not necessarily, because that is a large breeding population, we're not even certain that the characteristics upon which we are selecting our genetically controlled.

In the same way that I don't believe the last 50 or 60 or 70 years of high-grade logging on my unit, taking only the best and leaving the poorest, has necessarily caused a degradation in genetic quality of that population.

THE CHAIRMAN: Isn't a lot of that, Mr. Hynard, to some extent better determined in the lab setting where the nurseries are looking into putting together the components of a better tree genetically?

MR. HYNARD: I don't know the answer to that. I don't know if it is possible to determine, in a laboratory, if a certain characteristic is inherited or the case of bad luck. But, in most cases, we are not working in a laboratory we are working in the forest anyway, so...

THE CHAIRMAN: No, but aren't a lot of nurseries trying to develop trees with various characteristics that they believe--

MR. HYNARD: Yes.

THE CHAIRMAN: -can be better suited to particular sites or areas or disease resistant and things like that?

MR. HYNARD: Yes, that is true. There will be evidence on that in Panel 11.

MR. FREIDIN: That is basically I think referred to as the Tree Improvement Program?

MR. HYNARD: That's right.

MR. FREIDIN: Q. All right. Now, I think the third concept which you described was how through nature there was a natural selection or a survival of the fittest within the stands over time. And what is the significance of understanding that concept in relation to harvesting purposes?

MR. GREENWOOD: A. Well, understanding that genetic diversity can reduce within a stand over time through natural selection, reflected in a timber harvest which is planned and carried out to do a similar thing.

Mr. Hynard just talked about removing poor individuals from a stand. If in fact those

individuals are removed in a way that is analogous to natural selection, and I think it is generally referred to, an improvement selection cut, then the effect in the long term would be the same as that through natural selection within that stand.

If in fact you harvested in that way it could almost be seen as long-term gain for short-term pain in that you are removing poor individuals as well as good individuals and you might prefer just to take the good individuals.

THE CHAIRMAN: Isn't that the effect essentially of your thinning program, your tending program.

MR. GREENWOOD: The tending program can select on that basis, but it wouldn't necessarily. The thinning program is aimed more at providing more light and space and nutrients for those trees which remain and, therefore, allow the growth to go on to those stems as opposed to the many.

But since you are removing individuals anyways, you would normally select the better individuals to leave and, in fact, possibly speed up the natural selection process. And, again, this all hinges on whether what you are seeing is in fact genetics as opposed to just the effects of climate.

MR. FREIDIN: Q. You have indicated that harvest through the use of a selection harvest or part of the selection system is similar to survival of the fittest which occurs through natural means, but are there differences that you could comment on?

MR. GREENWOOD: A. There are differences. Natural selection does not select on the basis of economic traits; natural selection works on the basis of the ability of the remaining trees to reproduce and to survive and to compete.

Harvest does select or can select on the -- well, it always does select on the basis of economic traits, it may be selecting the poorer ones out, but if it is poor it is poor on the basis of economic traits, and if the selection in fact corresponds -- if the fitness corresponds with fitness in terms of the ability of those trees to reproduce and survive in the environment, then the change that would take place within that stand would be one that would be similar to natural selection.

If, however, those economic traits were not reflective of those traits which allowed the trees to survive and reproduce in the environment, then it would be in fact a different effect on genetic diversity within that stand.

Q. So if your harvest reflects or selects the same as would occur through natural selection, you have got a similar result in terms of the genetics?

A. That's correct.

Q. What does the phrase disgenic selection mean?

A. Well, disgenic selection is strictly a term to represent that practice where you -- what you are selecting does not reflect what nature would have selected.

Q. So in that situation then, if your selection for economic criteria was a selection of trees which wasn't the same as what would occur in that stand naturally, that would be referred or the choice within the harvest decision would be referred to as disgenic selection?

A. In a general sense, yes.

Q. Where you have disgenic selection, could that have a significant negative effect genetically?

A. Yes, it could.

Q. In what situations could that occur?

A. Well, there is actually four points that you would have to consider to determine whether it

in fact was occurring.

If you selected the individuals on the site based on their quality and removed the good individuals and left poor individuals on the site, but at the same time left other genetically related material, a material related genetically to the good trees on the site, for example through advanced growth, you would not have created a situation where genetic diversity would be reduced.

So that's the first thing: Have you left any genetically related material on the site, and that could be through root suckering or stump crop as seed, advanced growth or even younger trees of the same species that were related.

It could also only occur if in fact this selection was carried out across the whole population in a relatively short period of time; that is, if genetically related material from elsewhere in the population was able to invade the site that had been selectively harvested or had the better material removed either through pollen or through seed, then there wouldn't be loss of that material on the site and definitely not within the population.

Also, one of the other factors that we have mentioned one or two times is that the criteria --

the selection that you are using is based on phenotype and that phenotype would have to be related to genotype. If you were selecting based on quality and the reason that those trees were of a higher quality was strictly related to climate, you would not have affected the genetic diversity even at the stand level.

And another criteria, if you were in fact selecting these higher quality trees within this stand, it would have to be intense, you would have to be removing all of the good quality trees and, in most cases, it would have to be repeated as well in order to have affected genetic diversity negatively.

Q. Now, if through -- if genetic diversity has been reduced negatively, is there any ability of a species to recover from that reduction in genetic diversity?

A. Yes, there is.

Q. Can you explain again when that can occur or -- all right.

A. Well, it is not so much when, it is based on the fact that trees have great inherent genetic diversity within them and they also go through a very heavy natural selection process after they have seeded into an area and, therefore, when the trees sexually reproduce, there is the chance that because of

the diversity within their genes they will reproduce a good tree again.

So even two poor trees are carrying characteristics of the better quality trees and through sexual reproduction can produce a tree of the higher quality and, therefore -- and when that -- that combined with the fact that heavy natural selection will favour that tree creates the situation over a long term, better quality trees could form part of that stand again.

Q. Okay. Mr. Greenwood, I understand that you have some slides that you would like to show and these are going to basically be demonstrating some of the matters that you have testified to; correct?

A. That's correct.

MR. FREDIN: Now, if I just might, Mr. Chairman, I think this is primarily for the assistance of the exhibit keeper, the way these photographs are going to go in is a little confusing so I would like to explain what we are going to give you.

First of all, the list of photographs which are reproduced in the witness statement are found at page 208 to 212 and there you will find the pictures and a brief description -- pardon me, you will find a brief description of those pictures at pages 208 to

212. There are 53 pictures described.

Commencing at page 278, you will find copies of the actual photographs. Mr. Greenwood will not be showing all of the photographs, primarily because some of them relate to subject matters which were not addressed by him but rather had been moved back into Panel 9 and were addressed by Mr. Armson.

I can advise you now, and the parties, that the following photographs will not form part of the presentation today and those photographs are 1, 4, 5. 6 --

THE CHAIRMAN: Are you working off of the actual photographs or the list?

MR. FREIDIN: The actual photographs and the list should correspond.

MR. GREENWOOD: They correspond.

MR. FREIDIN: In fact, Mr. -- so 1, 4, 5 6, 12, 13, 14, and 50.

MS. SWENARCHUK: Five zero or five one?

MR. FREIDIN: Five zero. Now, what I am going to give to you, Mrs. Koven, is an envelope which contains - with an exception which I will explain to you in a moment - copies of the photographs which will be shown today in the slide presentation taking out the ones that I have just referred to.

with species/site relationships.

You will be talking about other things those photographs demonstrate, but primarily that's the main reason for producing them, and the slides which fall into Category A are 7, 8, 9, 10, and 11.

THE CHAIRMAN: They are going to be shown in that order?

MR. FREIDIN: They will be shown in that order and I am not paying Mr. Greenwood anything for repeating the numbers.

Category B is erosion. The slides which fall into that category are the following, and in this order: 15, 3, 16, 17, 18, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44 and 45. I sound like I am announcing the Wintario numbers.

Now, No. 15, Mrs. Koven, the hard copy of that is not included in the package I gave to you, it is in Toronto and we will provide a copy to you.

Category C, compaction and rutting. The following slides will be shown: 2, 20 through 25 inclusive, 19, 26, 29, 27, 28, 30 through 34 inclusive. And the slides in that package which are in Toronto and aren't part of the hard copy which I have given to you are -- and, Mrs. Koven, I don't know whether you have to make copies of these, what we have done is we have

Now, the order in which those slides appear in the actual hard copy I have given you and the order which will be followed in the presentation does not follow the order which is set out in the witness statement.

THE CHAIRMAN: It makes perfect sense to us.

MR. FREIDIN: That has occurred because some of the photographs which would have appeared as No. 1 -- you explain it, Mr. Greenwood, it drives me nuts. Explain why you have moved the numbers around to make things difficult -- other than to make things difficult.

MR. GREENWOOD: Some of the photographs which originally pertained to the topics which were moved into Panel 9 were going to be used to demonstrate points also in evidence that I led. So the only way to put any sort of order to it was to move them into the topic now which was being discussed as part of this evidence.

MR. FREIDIN: Okay. Now, the slides which will be presented fall into four categories and Mr. Greenwood will be identifying when he is going from one category to the other, but just so we know in advance where we are going, let me say Section A deals

inserted a piece of paper in the right order with the number of the photograph that you are going to get - but they are, compaction and rutting section: 20, 21, 19, 26, 29, 27, 28, 30 and 31. That's the order in which they will appear once you get your copies.

And the last section, Section D, deals with diversity and those photographs or slides, all of which are in the envelope, 46 through 49 inclusive, and 51 to 53 inclusive.

MS. SWENARCHUK: And the topic?

MR. FREIDIN: And the topic in a very general way is diversity, forest diversity. And, as I have indicated, some of those photographs are being spoken to for more than one purpose, but generally that is the categories into which they fall.

So with that introduction, I suppose we could either turn out the lights and show the photographs, or if you have any other views as to what we should do at this particular stage, Mr. Chairman, I'm all ears.

THE CHAIRMAN: Should we give it an exhibit number?

MR. FREIDIN: I leave it up to you as to how we should mark that as an exhibit.

THE CHAIRMAN: Exhibit 1,000.

MR. FREIDIN: Let's go, let's go.

THE CHAIRMAN: I think we are up to 465 and I guess we can call the photographs collectively Exhibit 465 and then refer to them in the order in which they will be shown.

MR. FREIDIN: I think by the number that corresponds to the number in the witness statement.

THE CHAIRMAN: Right.

MR. FREIDIN: Okay. I think that's the best way otherwise people who don't have the hard copy will have difficulty understanding which picture we are looking at.

THE CHAIRMAN: But in the order that they are going to be shown; is that correct, because you are not going to show them in the order they necessarily appear in the witness statement?

MR. FREIDIN: No, they are going to be shown in the order of the numbers that I read to you. They are numbered in the witness statement, so all I am saying is the first -- I think I know what your problem is. The first slide is going to be slide No. 7.

THE CHAIRMAN: That's right.

MR. FREIDIN: And I think that should just -- we should probably just mark the exhibit as being whatever number it was and saying this exhibit is

composed of the following slides, the numbers of which correspond to the numbers in the witness statement in the following order and and then reproduce 7, 8, 9, 10, 11, because when he shows the picture -- the slide, I think he is going to say I am showing you slide No. 7. So that's how I suggest that we do it.

There may be -- I wouldn't be surprised if there is an easier way of doing it, I just can't think of it at the moment.

---Discussion off the record

THE CHAIRMAN: All right. Mr. Martel is suggesting, why don't we say that they are all 465 but then for each particular one it would be 465(7), for instance.

MR. FREIDIN: Sure.

THE CHAIRMAN: Then that will correspond with what is in the witness statement.

MR. FREIDIN: I think you are doing basically what I have suggested, Mr. Chairman, which is just adding...

---EXHIBIT NO. 465: Hard copy of photographs contained in Statement of Evidence for Panel 10 (page 278-293) numbered respectively.

THE CHAIRMAN: Okay.

MR. FREIDIN: Are we going to show those

now? How long do you think that will take, Mr. Greenwood?

MR. GREENWOOD: Probably three quarters of an hour or less.

THE CHAIRMAN: All right. Why don't we go through the slides now, then break before we go on with Mr. Clark.

MR. FREIDIN: Okay. Can somebody turn out the lights, please.

MR. GREENWOOD: What I thought I would do is start by showing five slides that demonstrate some of the points that we talked about, particularly when we were discussing rutting and compaction and erosion and that's the relationship between vegetation and the site and the fact that you can get an indication of site by looking at that vegetation that is in existence on the site.

MR. FREIDIN: Q. Just one moment, please, Mr. Greenwood. I know you are not going to announce the numbers and I have lost my sheet.

MR. GREENWOOD: A. Slide No. 7, Mr. Freidin.

Q. Well, I have lost the sheet so I am relying totally on your ability to number the number.

A. Then it will cost you a dollar.

to a person examining this vegetation to get an indication of site that we are on a relatively rich site, it more than likely has a fine texture, or if it is not a fine texture, then moisture is high in the soil for some other reason. The duff layer on this site is probably relatively thick, 10 to 15 centimetres thick, there is a lot of material which will be adding litter to that layer.

He would consider the fact that you have a heavy root mat in terms of the shrub layer that's there as well as the canopy layer, and all of these things have ramifications for those topics of compaction and rutting and erosion. If you remember some of the key factors that we were looking at were soil moisture, soil texture.

Q. Could you indicate what is it about what you would observe in that slide which would indicate that you were on a rich site?

A. It would be all of the factors that I have just listed. The mixture of canopy species would indicate that. Poplar will grow on low nutrient status sites, but particularly when it is in a mix like this with a strong undergrowth and understorey advanced growth, they would all be indicators that you were on a relatively nutrient rich site.

This stand is a mix in the overstorey of jack pine. You see the jack pine here and aspen, poplar. The trees, if you were walking into the site and trying to get some indication of what was going on with moisture and soil texture, you would notice that those trees are fairly large.

The gentleman standing beside the poplar -- or, sorry, the jack pine would give you some scale that that's, for jack pine, is a relatively large tree. There are also relatively large -- and when I discuss these indicators of site, I am not attempting to do so in a quantitative way, it is relative.

The other thing that you would notice immediately moving on to this site is that there is a thick understorey of vegetation, in fact the gentleman would probably have to battle his way into that tree. It would be alder and hazel, possibly striped maple in this understorey. You would also notice the presence of advanced growth within the understorey, we have some balsam in this understorey.

And one of the other things that a forester would be noticing is that as well as the shrubby undergrowth there is a herbaceous undergrowth in this understorey.

Now, all of these things would indicate

Now, we talked about diversity as well and you can see in this stand that it very much represents the stand No. 1 that we walked into. There is an overstorey with two species and, therefore, we have diversity in that overstorey. We also have younger trees in the understorey in the form of advanced growth so we have age diversity within this stand.

And if you look carefully you can also see small and large jack pine. There is a small jack pine compared to this large one. That may be a reflection of genetics, it may be a reflection of competition that that smaller jack pine has had from the poplar.

Now, on the next site, this is slide No. 8, you would notice that there is still a mixture of overstorey species although it is more difficult to see. There is poplar in the background in here, but we now have a far higher component of jack pine. That in itself would tell us that we have moved on to a somewhat drier site. When we look at the understorey, you will notice that the shrub layer is not as tall, it is not as thick or as prolific, and that also will be an indication of a less nutrient rich site and probably a drier site.

In terms of the potential for rutting, the last site, because it would be finer texture and have a higher moisture content, would be one of those sites which could be rutted under certain conditions. If that last site had a high moisture content for instance in the spring, it would more than likely be susceptible to rutting. This site would be less susceptible and you really couldn't determine if it was or wasn't until you checked the soil.

In terms of an undergrowth, we have quite a strong understorey of balsam fir and probably some spruce as well. So we have in this, in terms of diversity on this stand, also diversity in species, diversity in age. And, again, it is hard to point out on the slide, but you would be able to, probably with this high component of jack pine, pick out stem form differences that would reflect differences in a genetic diversity within the jack pine species.

Q. Could or would?

A. Which could. So in terms of actual soils, I mentioned that the last slide would have a high component probably of fine-textured soils, by moving on to -- by the change in vegetation, I would infer from this vegetation that we have a higher component of coarse material now or coarser material,

sand.

This is slide No. 11. In this stand we are in a pure or near pure stand of jack pine now. You will notice that there is a very limited shrub layer in the understorey, particularly when compared to the first slide that we looked at, slide 7.

I am sorry, what did I call that slide number?

MR. FREIDIN: 11.

MR. GREENWOOD: My fault, sorry, slide 9.

The shrub layer that is there is relatively short but it is still there and there is still herbaceous growth mixed in with that shrub layer which would indicate that we are on yet again a dryer site than the previous slide, slightly less nutrient rich and there is possibly some sort of a gravel component to this soil. It could in fact be the same soil type as the last one, but if you had the presence of rock or gravel in the soil it could affect drainage and, therefore, moisture content.

In terms of diversity now in the canopy, there is really not species diversity, although I do notice -- no, that's right, it is pure. There is a minimal amount of advanced growth but there is one here so we would still have some degree of age diversity in

this site. But you will notice that the jack pine has different diameter, you have one here which is quite small in diameter compared to its neighbor.

We also see stems that have crooks in them and in fact this one has -- looks like it has already died. These could be indicators of genetics again, particularly when you are examining stem form.

In jack pine, a ripple to the stem we know reflects genetics. This stem here you will notice takes a little ripple here and then again here as opposed to this stem which is relatively straight. That would probably reflect genetics in this stand.

Slide No. 10. We are now still dealing with pure jack pine. You will notice that there is a continuous undergrowth of a low shrub, in this case it is Labrador T but there is minimal herbaceous growth.

Something else that you will notice is that the trees are much smaller. And from the crown shapes I would suggest that this still is a relatively mature stand as opposed to a young stand. Jack pine tends to branch differently when the trees get older and put on less leader growth. So the size in this case, would reflect site and you could interpret vegetation like this to imply quite a dry site, probably low in nutrients and our organic layer is

probably getting quite thin here as well, a lot thinner than the 10 to 15 centimetres of the first site.

Q. What would indicate that to you?

A. The dryness of the site and the amount of biomass that that site is carrying in order to develop an organic layer. In terms of compaction or rutting, a dry site like this would not be susceptible in any season.

Q. When you referred or used the term organic layer in that answer, what are you referring to?

A. The forest floor. In terms of diversity, we are looking at single species in the overstorey and very little diversity in the understorey. There is no age diversity in that there is not advanced growth but, again, we do have different diameter jack pine, different stem forms and, therefore, some reflection of genetic diversity.

Our last slide in this sequence, Slide 11, again, we are in a pure jack pine stand, there is no shrub layer in the understorey, there is very little herbaceous growth, if any at all. In fact, the major component of the growth at the forest floor here is lichen. This site is a very dry site. It would be low in nutrient status. The duff layer would be quite thin

and, again, a site such as this would not be susceptible to rutting or compaction.

It would be quite a coarse site, either in terms of gravel or in the coarseness of the sand and, therefore, water would infiltrate the site as opposed to runoff and there would be quite high bearing capacity or strength to this soil, a large amount of macro-pores in terms of the macro-porosity that we discussed.

And lastly, in terms of diversity again, single species, no real understorey or advanced growth, therefore, no age diversity but, again, you get different stem diameters and would have different stem form which would, in all probability, reflect genetics of the species.

THE CHAIRMAN: Mr. Greenwood, would you ever get a situation where the stem form would be the same throughout a stand in any event?

MR. GREENWOOD: You would get stands where the difference would be manifested more than others, correct, but normally -- the one that I chose was chosen on purpose in that jack pine tends to show that variability regularly and it is quite visible. It is one of the key characteristics in jack pine that is controlled by genetics and is quite visible.

In terms of Slide No. 15, moving on to the topic of erosion in a little more detail. We talked about the forest floor, in this case, organic layer acting to protect the soil underneath it from erosion. The forest floor - this organic layer - has good water infiltration and, therefore, the water moves into the soil as opposed to over top and the forest floor also would protect -- sorry, yes, the forest floor would protect the mineral soil from the action of wind.

We talked about the root development and the root layer - root mat - that can be at the top of the surface of that mineral soil and that can also afford some degree of protection in holding the soil together. In terms of compaction, we discussed the root layer and also the protective layer of the organic matter as well.

Slide 3. This is an area that was clearcut in the summer near Chapleau using the full-tree method and what I wanted to demonstrate through this slide was the fact that mineral soil exposure is quite limited even following full-tree harvest in summer. The mineral soil shows very well in this photograph, it is bright white along the roads and yet within the harvested areas there is very little

incidence of mineral soil exposure. I can see one little patch there. The rest of the, area the root mat is fairly continuous.

Another factor, if you are concerned with erosion or if you are looking for flags for it, this has flat topography, the ability for water, even if soil was exposed, to run off would be quite limited because of a lack of slope. Another factor where the soil has been exposed, you can see boulders and rocks and, from experience when the exposed soil is this bright in colour, bright white, we know that there is a heavy sand point to it. We are looking at quite a coarse material here and, therefore, very little potential for erosion.

Slide 16. I just wanted to demonstrate the fact that mineral soil exposure does take place. I mentioned in my evidence that these patches are small discontinuous. Here we have mineral soil exposure, this lighter area where the organic material has been removed, the patch is quite small and it is typical of the type of exposure that can take place during a summer logging operation. On many sites this would be considered a positive effect in that we would be attempting to create some mineral soil exposure for subsequent renewal activities.

Slight 17 shows how windflow can create a similar patch of exposed mineral soil even though you can't see the patch, I think, you can see the soil that is in these roots and the fact that the organic layer has been uplifted. At the base of this tree would be a patch -- a smaller patch as well of mineral soil which had been exposed.

Slide 18. This is another slide showing disturbance that can take place following logging. Here you have disturbance of the organic layer. You can see that you have areas that are fairly brown or black where that organic layer has been disturbed, but mineral soil exposure has not taken place. On this particular site the organic layer is probably quite thick.

I mentioned in the evidence that susceptibility to erosion would normally be determined by flags or cues, this was Slide 35, and we talked about wind erosion and some of the cues that you might look for. On a site like this, this is the lichen site which you saw a few minutes ago. There is a very thin organic layer over the soil. This site is very dry, so I know that I'm probably on a sand texture, but the cue in this area is the slight change in topography in the background, right here (indicating), and there is

another one starting here (indicating). When you are walking into an area these would stand out because most of the area is quite flat. And what in fact we are seeing here are sand dunes. This area has blown in the past and just that one flag, that one cue, the presence of a sand dune, would be an indicator to the forest manager that there is a potential on this site for wind erosion.

In determining that they were sand dunes the manager would probably be considering the fact that it is a dry site, you can see sand on the road, and therefore, two or three of those cues confirm the fact, you also could check surficial land form maps -- surficial geology maps I should say and these dunes may be mapped. You can confirm on aerial photos where he gets a larger picture how extensive this deposit is and, therefore, forms prescriptions based on that.

This is the same site Slide No. 36 where the mineral soil has been exposed. This exposure is in fact on the side of the road and forms part of the road and it shows that where the mineral soil is exposed, the organic matter has been removed, wind will move this particular texture which is a fine sand, a pure fine sand. You can see that it has blown into the stand in two places here. (indicating)

The other thing that you can see from the picture is the significant effect that the organic layer does have even, though in this site it is very thin, in controlling erosion. Where we have wind moving soil here, the boundary is still fairly distinct where that organic layer is in place and movement is not taking place from within that stand where the organic layer is still in place.

Slide 37 is the first in a series of three of relatively normal till sites in the boreal forest. And why the comment was made that erosion is not significant, particularly when we are determining or examining site productivity, some of the factors that would play here. I am going to take you through a sequence of operations on this site. Two of the pictures are from the exact location and the third picture I will have to point out a few cues to show you where we are. This is Slide 37 if I haven't said that.

Immediately following harvest on these sites one of the things that is fairly prevalent is the slash and organic layer across the ground and, in fact, ground vegetation as well which, following harvest, is acting to stablize that site or prevent erosion.

This area was full-tree harvested in 1983. It has some topography, but it is minimal. We

see the presence of coarse rock, they are rather angular and we get an indication again that this is probably a till and, as such, has a mixture of soil types but with the rock component in the soil would drain fairly readily.

MR. FREIDIN: Q. What part of the site are we looking at in this picture, the part here with all the slash on it?

MR. GREENWOOD: A. What part -- oh, this is the roadside, I am sorry. This is a skidway atf roadside and the slash has been concentrated along the roadside and in fact we see a rut which has been formed here, where the equipment has worked at roadside and the ponding which has taken place inside it.

This would be typical of the type of rut that you would still find throughout the area of the undertaking. It is small in extent.

Q. And the area that was full-tree harvested, is that the area in the background of the picture?

A. The boundary of the harvest in this case would follow along here (indicating) just over that hill. So this area in the background has not been harvested -- actually this hilltop has been in the background so this would be the back boundary.

Everything in the foreground has been full-tree harvested.

What you should keep your eye on are these two logs and this rock in the next picture.

Q. Mr. Greenwood, do you know or do you have any information as to when that picture was taken in relation to the harvest?

A. It was taken shortly after the harvest.

Q. Sorry.

A. I just can't remember whether that site was winter harvested or summer harvested, so it would either be the summer after a winter harvest or the following summer. So it would be six months to a year following harvest.

Q. All right, thank you.

A. Slide No. 38 is immediately following a prescribed burn on this site. You will notice that the ground vegetation which I said has some stabilizing effect has been removed. The light slash has been consumed, a portion of the organic matter has been consumed and the heavy slash has been dropped to the ground.

Where the slash was quite heavy in the previous photograph right here and here (indicating),

you will notice that we have a degree of mineral soil exposure. Throughout the rest of the site the organic matter is still in place and is still acting to reduce the susceptibility to erosion on this site, even without -- the absence of that ground vegetation.

This was taken within weeks of the previous photo. So this site still would have low potential for erosion even though there is some topography change because of the organic matter still being in place.

For the next picture you have to keep your eye on this leaning tree right here (indicating) that leaning tree is this leaning tree. So this is the same site Slide No. -- I'm sorry, No. 40 -- sorry to back up 39. This is four years after the prescribed burn. The area has been site prepared mechanically using the TTS disk trencher which creates a furrow in the soil and then was planted with jack pine.

The organic mat is still in place and the ground vegetation has regenerated and the jack pine is quite prolific, you can see it throughout the whole stand. So this site, which has gone through a series of operations from harvest and treatment, has had low susceptibility to erosion throughout and in this condition would be of extreme -- have extremely low

susceptibility to erosion.

Now, this is Slide No. 40. I included this slide just to point out the fact that excessive boulders should not be construed as any indicator of soil depth. Some people may look at a soil like this and assume that there must be very little soil here. In fact this is quite a deep till.

The boulders are large, they are angular, they have been dumped by the ice action of the glaciers retreating, dumped along with the soil and, in fact, this deep soil has its organic mat still in place between the boulders and as well as a vegetation -- a ground vegetation in place but in this season, which was spring, is not noticeable. So this site would also have limited potential for erosion, primarily because of the organic layer which is in place and the vegetation which remains in place.

I also mentioned when I was discussing erosion that the terrain is broken. Where we have do have some topography, we have depressions next to them. If, for example, erosion was taking place -- or could take place on this hill it would have very limited place to go. It would be deposited right at the bottom and there would be very little movement across the site.

This also is a sequence of slides. You will notice the hill in the next slide. This is the same site, Slide No. 40 -- I'm sorry, in this case Slide 41, same site eight years later -- sorry, eight years following harvest, six years after the previous slide. It is in the exact location.

There was no treatment on this site. This is natural regeneration which is taking place and we can see the component of conifer in the stand as well as - there is another one, there is another one - as well as the birch and poplar which has regenerated on the site. This site in this condition with this type of growth would not be susceptible to erosion.

Q. And which species is the predominant one in that slide?

A. It is pretty hard to tell. It would be either poplar or birch. There is a mixture of both in there.

Q. And would there be a reason that that site wasn't treated but had been left for natural?

A. Primarily -- the primary reason would have been the boulders. It would have been very difficult to put equipment on that site and yet the duff layer is fairly thick inbetween the boulders. The other thing that is significant about that site, you

can see the lush growth and that site in fact is fairly nutrient rich. If you were to go in without site preparation and just attempt to plant in the duff, you would have two things working against you: One would be the depth of that duff, the second thing would be the degree of competition that would be on the site. It was originally a mixed wood site and it will regenerate back to a mixed wood site.

Q. Thank you.

A. This is Slide 42 and here we have what I think could be characterised as shallow soil over fractured bedrock. You will notice that there are pockets of soil inbetween the bedrock, outcrops, and this would be representative of the sites that Mr. Armson referred to as fractured bedrock but a boreal example.

One of the things that he mentioned about these sites is that there is nowhere for the soil to erode to and you can see even with this hillside that it would be trapped pretty quickly if it was eroding in the pockets and in fact naturally has done so over time.

This also is a sequence The next picture I couldn't get this close because the area where this picture was taken from was heavy to vegetation, but if

you keep your eye on this particular rise in the bedrock and the shape of that, plus this poplar, I think you will be able to identify where we are in the next photograph.

This is photograph 43. That bedrock rise starts here and goes across and drops off. (indicating) and that poplar is the same one - I'll maybe back up just so you can orient yourself again - whoops. So this is the change in topography, and the large poplar with the spruce on this hill, you can see -- just the lighting is poor -- but there's the poplar that lighter green colour, and the darker colour is the spruce on the hill.

So this site -- sorry, I should say this Slide 43 is seven years later. This site following harvest was prescribed burned, modified mechanical site preparation worked those pockets of soil and planting of jack pine container stock took place following that.

You can see the depth of vegetation down here (indicating) - this is where I took the previous photo - it is quite tall now. That would reflect the moisture in that depression. This poplar also shows how where there is moisture you can get prolific root suckering just from one or two individuals. So this site has regenerated from those two or three residual

poplar that were left on the site. Elsewhere there is the jack pine which was planted.

Q. Can you just go back to the previous slide to see the depression that you are talking about.

A. The depression, you will notice down in here (indicating) that there is a lot of grass and green, that is quite wet, but the depression -- this area where I was standing was just the other side of those poplars and was also in a low area which would represent the area just right in here (indicating), and that bottom of the rock face would be that green area that I showed in this picture.

The mineral soil pockets between the bedrock outcrops has now been revegetated and there has been limited erosion from this site.

Slide 44 is just a close-up of the same site to show what has happened right where the bedrock outcrops were. The first thing I would point out would be the pocket of soil on this side where in fact you can see from the angle of the bedrock that it takes a dip and this area will contain the soil which did support the previous forest and is in fact supporting where the regeneration has taken place.

Now, this regeneration, as I said, was six years old and it is taller than myself, so it is

growing quite well in those pockets. That is pretty good growth if you are growing more than a foot a year on what would generally be considered a fairly nutrient poor site.

The other thing I wanted to point out in this photograph is the fact that there has been moss growing on this rock and that moss has been reduced somewhat in that when you opened the site the heat effect that I mentioned has probably dried this moss out and it has been able -- it has receded somewhat off the bedrock, although where it was thick and where there were roots, those roots are still holding that moss in place. So the change -- there has been change here, but it is very slight and, in fact, as this stand continues to grow and closes in it will create the humidity and moisture conditions for that moss to grow back onto the site.

I think the key here again is that the trees were in the pockets before and that is where they have regenerated again or where we have been able to artificially regenerate them.

Slide No. 45 --

Q. You are now getting into the slide which deals with -- I am sorry, okay.

A. One more. I mentioned in my evidence

and in the document in Panel 10 natural erosion and I just wanted to give you some visual impression of that. This is an area that is draining into Lake Abitibi which is just at the southern end of the Clay Belt, in fact, just as the Clay Belt starts to become more of a silt clay than a clay belt.

Lake Abitibi is just above this photograph, or just right close to where this river empties into Lake Abitibi and this river which is in fact draining that clay silt area carrying this load of turbidity year round. It has not been affected by operations, in fact there are no operations in the vicinity of this river upstream that would create anything like this. And Lake Abitibi is also very close to this colour.

The rivers which are draining into Lake Abitibi are draining this area and carrying this type of silt load or turbidity year round. The thing that is interesting here is that a river draining a different type to the south, and I said this was on the southern end of the Clay Belt, is not carrying the same load. And so this was just to reflect some of the natural erosion which can take place.

The next slide, Slide No. 2. We talked about compaction and rutting which is now the topic I

would just like to give some visual impression of.

I made the comment that outside the Clay Belt soils tend to be fairly coarse tills and, therefore, aren't as susceptible to such in a real sense as the Clay Belt area. This would be fairly representative of some of those coarse soils. It is a till again, there has been lots of boulders dumped and because of its coarseness in an overall sense would be low in susceptibility to compaction or rutting.

Now, there would be pockets within these areas which would be susceptible and could in fact, if equipment went through them, result in a rutted portion of the site, but on the whole the site would have a low susceptibility to rutting or compaction. Another factor that is obvious here again is the organic matter in place following harvest throughout most of the site, except where roads -- these are roads and skid trails within the site.

Slide 20 is an organic site. This area has not been harvested but it demonstrates how close to the surface the water table is within some of these sites. This slight blue colour here is in fact a reflection on top of water which is sitting right at the surface.

It is not a particularly good slide.

This is a black spruce on the left-hand side growing in this condition and you can see the moss, the spagnum moss, clumps or patches within this site of water. It is very close to the site -- very close to the surface on this site.

The point being that a site like this would have little strength, there is not a lot of ground vegetation that would give strength in terms of a root mat and such a site would be very susceptible to rutting if equipment operated on this site in summer time and had nod been modified.

We talked about the rutting that did take place. In Slide 21 you can see a situation where equipment was not modified for the site. This is an older area prior to FEC, prior to wide-wheeled skidders, and the dark patches here are in fact water throughout the whole area. So most of this area has been rutted. There are still patches of moss which are out of water, but a substantial amount of standing water has been created on this site as a result of rutting.

Q. And is that a picture of the cut-over; is it, part of the cut-over?

A. That's right. This would be a similar site to the previous one and after harvest,

after harvest in the summer situation.

Q. And is that condition an acceptable one?

A. Not in my mind, no. This site would create conditions very difficult for renewal on the site. The areas where the ruts take place would be invaded quickly by sedges and cattails which would in fact start the recovery of the site but there is very little micro-site here for either natural renewal or artificial renewal. It would be darned hard to get planters to walk across that site.

Slide 22. We talked about operation of equipment in wet weather. Here's a site right at roadside where rutting has taken place, where compaction -- it is a short slope, equipment has been travelling repeatedly on this section of ground. Because there is a short slope here it has had to work going up the hill and in fact has probably had slippage of its tires which has created some of these ruts.

We have had organic matter partially removed and mineral soil exposed. At the bottom of this slope when they are coming in loaded, because of the weight of that equipment hitting the bottom of the slope, they have caused rutting and compaction at the bottom of the slope which shows quite nicely because of

the water accumulation. Because of the compaction water won't infiltrate into the site, so it is ponded.

Once you are on top of this hill the organic mat is still in place and the same sort of occurrence is not happening, particularly if the equipment is starting to distribute itself across the site.

Such occurrences are generally limited to small areas such as this. This one is particularly severe because it is at roadside where all of the equipment has been channeled through, and also there has been the effect of road construction here in that bulldozers have removed the organic layer up to about the bottom of this hill.

Such a site would still regenerate except that it would take longer in these ruts on the hillside. This area still would regenerate quite satisfactorily and naturally. This area of rut would take a lot longer and the area that is compacted and ponded at the bottom would take longer still.

Slide 23. This is the same site but it demonstrates the same sort of thing. This, again, was at roadside, it again was an area where equipment was concentrated as it was coming off this hill and out of this area to roadside. It is a soft spot, you can see

the amount of the rock in the background. Most of this site has extremely high-bearing capacity, rock holds anything up.

But this was a soft spot at roadside where equipment repeatedly travelled through and rutted the soil, compacted the bottom and in fact has created some ponding. Again, the severity of the occurrence is quite heavy where it has occurred, but the extent of the occurrence is quite small and, again, would be representative of the type of rutting that you would still see out on sites.

The vegetation in the background here is two to three years old. This actual picture was taken five years following harvest. There is still -- there is some vegetation now coming into the bottom of those ruts, you can see some sedges or grasses here and, in fact, will start the process of reducing the effects of that compaction and rutting.

Slide 24 was previously shown by Mr. Oldford. Again, I just wanted to demonstrate the point that a lot of the disturbance that takes place takes place at roadside where equipment is manoeuvering and turning and working with heavy loads. This machine is in fact stirring up the organic layer and mineral soil.

There is some compaction taking place

here, water is sitting here as the machine tries to work and push these logs up into a higher depth. There is probably wheel spinning take place here. So we are getting an effect at the immediate roadside.

Slide 25. The severity of that effect, however, can be misinterpreted. Here we see quite substantial ruts, a lot of mineral soil that's been exposed and a lot of water that's sitting, but this is a roadbed.

The harvest operations quite often take place prior to the road going in or, in some circumstances, the road would be frozen and the area -- the logs would be hauled out in winter. Equipment can concentrate a lot of their movement on what will become the roadbed and thereby limit disturbance to the site.

In this particular case you can see that the organic matter is still in place on the actual site and that the equipment is doing its turning and manoeuvering on the roadbed.

Weather in both of these pictures is having an significant effect, there has been substantial rain and when this site was dry you would not get the same effect as you are seeing now.

Slide No. 19. When you have susceptible sites, particularly where they are large enough to

identify as opposed to smaller pockets, they are identified and designated for the modified operations. This is another organic site. It is not quite as wet as the previous one that I showed where we actually saw the water sitting, but in this depression you would probably find some water at the bottom of that.

This is first in a series of three slides which shows how modification of operations plus identification of susceptible sites has reduced the incidence of rutting in the Clay Belt area.

Unfortunately this is rather dark. This is Slide 26. This is on the same site type as the previous slide. There are still some things that we can show. If in fact this had been harvested using the normal narrow-tired skidder, at this point it would look fairly much like that site that was severely rutted.

You can see that the organic mat is in place, there isn't water standing on this site. It was harvested using a system that limits the amount of travel on the site. If you see in the foreground here, there is substantial advanced growth left, there are also diagonal lines throughout that advanced growth.

On this particular site, the harvesting equipment was limited to these trails, the areas

between were harvested using the feller-buncher that was described by Mr. Oldford, the equipment did not move in those areas between its rose, it reached into them with the boom from both sides, and the wheeled skidders that were used or modified and used, the wide-tired skidders, and even though this area was harvested in summer there is little site damage.

In the original photo - I am sorry it doesn't show well - there is a little bit of rutting between these two skidways where it is on the roadbed again, this roadbed -- this area will not be hauled until winter time and this will become the roadbed, it will be frozen and these logs will be hauled out. But, again, where the rutting took place, it took place as a result of the equipment manoeuvering and turning at the skidway at the roadside.

Q. Mr. Oldford, does that site represent in any way the site that you described where there was this careful logging method in order to protect advanced regeneration?

MR. OLDFORD: A. Yes, that would be very typical of that type of site.

Q. I am speaking in terms of the advanced regeneration that we see there as opposed to the soil?

A. That's correct.

MR. GREENWOOD: A. This photo in fact was taken, Mr. Freidin, from a guide which demonstrates just that, so it definitely was harvested by that method.

Q. Okay.

A. This is a ground photo, Slide No. 29, of the same site as a slide -- in fact it is the same area as a slide two back, showing the advanced growth on the ground which has been left, the skid trail which has had some compaction of that moss layer but very little disturbance to it and, in fact, for natural seeding some compaction of that moss layer can be important. So this site is largely in an undisturbed condition as a result of modifying the operations in the area -- first of all, identifying it accurately and then modifying the operations.

Slide 27. I am afraid the light in the room makes it difficult. This is the Ardco forwarder again referred to by Mr. Oldford. You can just -- I won't spend a lot on this slide, you can't see really. These are the feller -- these are the bunches of trees which have been left behind by the feller-buncher and this machine is collecting those and moving to roadside.

The point I wanted to make with this slide again was that this particular -- the use of this machine limits travel on the site by the fact that it can carry what would take three skidders normally to move to roadside.

Slide No. 28. You can see the machine a little better now. It has large tires, three sets of them as opposed to two on the normal skidder, two at the back where the load is actually being carried. It has a grapple here which has picked up two or three bunches left by the feller-buncher and is carrying it on the back skidding the tops.

What I wanted to demonstrate in this slide was two things. This is on the same site as the previous slide, unfortunately you couldn't see as well as you should have, but there was very little in the way of these dark patches which are in fact -- which is some disturbances to the organic layer. The point of this is that sites are not uniform even once they are identified as a general site type.

This particular pocket that we are looking at is a drainage way. Water is draining laterally in this pocket on this side and on the other side there is very little disturbance of the soil, but this machinery, as it goes through this drainage way

where there is more decomposition of the organic matter and less strength in that organic matter, is causing some disturbance.

Now, the second point that is demonstrated by this is how a well-trained operator can limit disturbance. This particular operator has put two poplars bridging this drainage way and he is using those poplars as a bridge to increase his flotation when he crosses the drainage way. That type of on-site modification of operations is something that couldn't be planned for, but it is very important in limiting the amount of disturbance that can take place on a site.

Mr. Oldford referred to the amount of pressure that some of this equipment puts on the ground. He talked about footprints in some of those. This is an illustration of just that.

This is Slide No. 30 which shows an area, the full width of the photograph, which a wide-tired or high-floation skidder has passed over. You can see some of the imprint of its tread and a person walking through that area and the depth of the imprint that the person left.

Slide No. 31. We have spoken a lot about the wide-tired equipment and the effect it has had on

the Clay Belt area or susceptible sites. This particular piece of equipment, the feller-buncher, has been equipped with wide tracks as opposed to tires which also increase the ability of that piece of equipment to float on top of the soil. It has created compaction or an imprint within the moss. This imprint is acceptable and would not create any loss in productivity or ability to renew that site.

Slide No. 32. One thing I didn't mention in the evidence was that often what is seen or considered to be the results of compaction is often the results of nutrient removal. In fact, I don't think I have seen the results of compaction actually evidenced by reduced productivity, but I have seen on landings where compaction can play a part, reduced productivity due to nutrient removal.

As was mentioned in earlier evidence, landings are not used extensively in the boreal forest. They were at one time, now it's mostly skidways at roadside. This is an older landing which was in fact planted to jack pine. The jack pine that's in front of this gentleman, which is at his chest, is actually bigger than some of the ones in the foreground and was planted at the same time as the trees in the background.

So on this site the organic matter and the upper soil was removed and trees have survived but are not growing very well, and there is also, you will notice, very little presence of ground vegetation.

I say that this would not be as a result of compaction because what we are on is a relatively coarse sand here, a medium sand, and a medium sand is very difficult to compact to the point where you reduce that macro-porosity to the extent that you could affect growth.

I don't know if you can see it, but there are still small patches of organic layer that were left and the trees actually on those sites are a little taller, they respond fairly quickly.

Q. Through what activity would the nutrient be removed from that landing?

A. When the landing was created it would more than likely be created at the time that the road was made and a bulldozer would just go in and remove all of the vegetation and level the area out in order to leave a spot for the skidders to operate. And so it is this action of bulldozing and leveling the area that would have created that landing and removed the nutrients.

This landing, by the way, in terms of

extent would be probably about 40 feet long by 20 feet wide. So, again, it is not a large area but the effect on that area has been quite severe.

Q. When a skidway or a landing like that was put in and you say that there would be a removal of some of the soil where you have the nutrients, are you referring to removal of the organic layer, the removal of the mineral soil or both?

A. Well, there is still mineral soil there, but I am referring to both. If in fact just the organic layer was taken off, there is still quite a large reserve of nutrients in that weathered portion of the soil, again, as described in Panel 9.

So in a site such as this, there has been a substantial amount of mineral soil removed as well as the organic layer. You have gone low enough into the mineral soil that whatever equipment was working there has removed that portion of the mineral soil that carried nutrients.

This is a similar example at Slide 33. It is another landing, you can see the coarseness of the sand in this case. The reduction in growth is not as great as the previous one and this demonstrates just the point that you are making, Mr. Freidin, that there is still -- the depth of the removal of the mineral

soil on this site has been less than on the previous site.

Slide 34. If in fact the removal of this nutrient layer takes place, there are processes which -- of natural recovery which will allow the site to revegetate again. This is natural revegetation. This has been a landing, you can see that there is quite a change in vegetation here. There is a light green colour across the back and again out here. That is a fairly normal extent of a landing, and the vegetation within that landing is a darker green in colour. What you are seeing is alder growing on this area which has had the nutrients removed and the normal revegetation and regeneration taking place on the other site.

Now, the significance of alder here is that alder is able to obtain its source of nitrogen from the air through a process called nitrogenfixation and, therefore, is able to grow in this condition where probably the mineral soil has not been removed to a large extent, but the organic layer has been removed where a large source of the nitrogen exists and, therefore, these particular shrubs are getting their nitrogen from the air.

The significance of that is that this

site is in a process of natural recovery now in that these trees will be dropping organic leaves and debris onto the floor creating a new organic layer which will in fact allow other species to reinvade the site.

Q. And are you aware as to when that picture was taken in relation to the time of harvest?

A. Yes, this particular site is eight years following harvest.

MR. FREIDIN: Mr. Chairman, I think we have got another six or eight photographs. I would suggest that this would be a convenient time for a break.

THE CHAIRMAN: Okay. We'll take 20 minutes.

---Recess taken at 4:05 p.m.

---Upon resuming at 4:30 p.m.

THE CHAIRMAN: Thank you. Be seated, please.

MR. FREIDIN: Q. All right. Can we perhaps show these slides that deal primarily with diversity now, Mr. Greenwood.

MR. GREENWOOD: A. Yes, I think we can move through these fairly quickly. This is a slide taken from within the boreal forest and it was just -- I just wanted to utilize it to point out the mosaic

that I referred to when I did the diagrams.

You can see within this area there are areas that are relatively pure in their species, there is other stands which are relatively pure but to a different species, and there can be quite sharp edges between them, and there are also stands which have mixtures of species and in fact that mixture can change and create an edge between them, but not quite as strong an edge. There are also -- I am sorry, Slide 46 I think this one is. That is all I wanted to say on this slide.

Slide 47 were site types, in particular in this case, a major land form is relatively pure that can reflect itself in relatively pure vegetation. This is a large glacio-fluvial deposit, it is waterlain sands, sands lain by moving water south of Chapleau. The area is supporting pure jack pine for virtually virtually as far as the eye can see here, you can see that it has been harvested partially in the background, but this whole area is pure jack pine. I will outline it here, so some numbers of miles.

In this particular case site and disturbance has created a large single species or limited species diversity portion of the forest. The other thing that is visible on this slide is that

harvest, by removing mature forest and regenerating the forest, is creating age diversity within the forest.

Slide No. 48, I was using as a good example of within stand diversity. You can see within this stand that there are a number of species, there are in fact a number of heights of species, and you would not only have species diversity in such a stand you would also have age diversity this stand. Again, if you look into the horizon you can see that there is in fact a mosaic effect.

Q. Do you know what the area is - can you just go back to that - the area to the right of the road just before the turn?

A. This bare area?

Q. Yes.

A. Yes, that area is probably an area of a gravel pit where material was used to build the road and that also would be what -- where the water is sitting at the side of the road, this is an area where material has been taken and put onto roadbed to form the roadbed.

Photograph 49. This is showing some of the species diversity but now in the Great Lakes/St. Lawrence Forest. Within this area you will notice that there is a difference in species, however, there are

patches where the prevalence of a particular species changes, the same on this side. So we have within stand diversity we also have between stand diversity also in the Great Lakes/St. Lawrence Forest.

I used some examples of harvesting and natural regeneration and the effects on diversity. One of the examples was clearcutting a poplar stand and allowing the stand to regenerate naturally through root suckering. This is an example of just such an area where the poplar was clearcut and, in fact, what is created is again a pure stand of poplar or near pure stand of poplar and, as such, species diversity has been maintained. The harvest itself however has created an age diversity with neighbouring stands.

Q. That was Slide 51?

A. That was Slide 51, correct. This is Slide 52. What I wanted to demonstrate with this slide was again harvesting creating diversity of age but harvesting in this sense is also maintaining a relative -- I'm sorry, the species diversity is being maintained over a larger area and that even within areas that have been harvested and regenerated -- parts that have been regenerated, there are patches of other species within them.

In some cases this will be influenced by

the disturbance in that there may have been some residual poplar here which root suckered or it maybe an influence of a site factor where there is a change in soil vegetation. If you can visualize this stand when it is grown up, you will in fact see patches again of diversity of species similar to what you might see in the area which is not harvested where there is a patch of poplar mixed in with the conifer.

Distributing go the harvest over an area you can increase the age diversity to what would have existed on this site prior to harvest resulting from a natural disturbance such as fire.

My last slide just demonstrates - Slide No. 53 - that some of the site factors are very important in determining diversity. We have poplar which has regenerated naturally on this site which has completely overtopped what used to be a jack pine right here. So this tree has succumbed to poplar competition as a result of probably two things: The disturbance that took place which allowed the poplar roots to sucker and also a factor of site.

This is probably a fairly rich site. If it was in fact a dry site, jack pine would more than likely be able to out compete the poplar. So site could have quite an effect on diversity.

That is my last slide.

MR. FREIDIN: Perhaps somebody can get the lights, if somebody knows where the lights are.

Q. Now, in some of those photographs that we looked at, Mr. Greenwood, you looked at vegetation and based on the observations or the cues, I think you referred to them, you interpreted what some of the soil characteristics would be.

And just by way of summary, can you indicate the parameters of soil characteristics that you interpreted?

MR. GREENWOOD: A. I was implying from the vegetation certain characteristics of the soil texture and the soil moisture and through an understanding of both of those some indication of nutrient status of the site.

Q. And tell me -- one moment. How confident are you in your ability to interpret cues such as the ones you have indicated that are provided by vegetation - I think you said there was some angular rocks in some cases - how confident are you in your ability to interpret those sorts of things to predict soil characteristics or the parameters of soil characteristics that you referred to?

A. Two things I think would be at play

there. First of all it would depend upon the degree of refinement that I was trying to predict to. The second thing would be where I was making the prediction.

On my management unit I was quite confident, I knew the types of soils that were there, the types of land forms that were there, I knew the types of vegetation that were associated with those and, therefore, I was quite comfortable in using those indicators for determining the site characteristics.

Now, that would be as a result of the fact that when I first went on to that unit and I was using these indicators I would be checking, I would be truthing the information that I was interpreting and, therefore, learning more about how those interactions took place which takes me back to the first point of refinement. On my management unit, I could probably, using those indicators, determine information about the soil to a rather detailed level of refinement.

If I was taken out of my management unit my confidence would be reduced somewhat, not in terms of broad characteristics because the broad characteristics are in fact general enough and so general in fact that the terrain classification that I led is for the whole boreal forest in Canada.

So if I knew where I was within the area

of the undertaking there are areas where my confidence would still be fairly high.

I worked in northern region for a number of years, I learned the land form associations there with vegetation and, therefore, within that area - although I could not interpret it to the level of detail that I could on my management unit - it would still be to more detail than say interpreting around the Thunder Bay area where I have never worked.

Q. And would you be able to interpret around say the Thunder Bay area in the broad sense?

A. Yes. I am sorry, in the broad sense that would still apply.

Q. And is it necessary, in your view, to be able to predict to that degree of refinement that you feel you would be confident in predicting on your own management unit -- is it necessary to in fact be able to predict to that level of refinement in order to make sound and reasonable silvicultural decisions?

A. No, I don't think so. There is latitude within silvicultural decisions. The level of refinement would allow me to possibly prescribe a silvicultural prescription which would take into account a factor of site that could increase growth generally, however, the types of treatments that you

are utilizing are broad enough that the broad interpretations of those indicators are enough to make a silvicultural description or prescription.

Q. Thank you. And if you were in one of these situations where you were predicting on a broad range and for some reason you wanted some more refinement, do you believe that there would be people say on this new unit in the Thunder Bay area that you had gone to who could be helpful to you in terms of making more refined decisions?

A. Very much so. There are always staff that stay on units which have that level of refinement and can pass it on to a person who is just new to the unit and that would be the case throughout the area of the undertaking.

Q. Okay.

Q. Mr. Hynard, during the evidence I believe in relation to genetic diversity and during the description of the three concepts that Mr. Greenwood wanted to describe to the Board, I asked you a question, and during that question I think you used the phrase -- you referred to high-grading and you said, I think, high-grading on my unit over the last 30, 40 or 50 years or something to that effect.

Were you suggesting -- over what period

of time -- or is high-grading still going on in your unit?

MR. HYNARD: A. No. If my words left the impression that high-grading was occurring on my unit that is a false impression, au contraire. In fact our practice is more low-grading today, taking out more low-grade material and keeping those trees that were capable of producing quality material growing.

Yes, high-grading did occur on my unit, it occurred since the earliest settlement days but in hardwoods I think really over the period from about -- when truck hauls began in the 1930s, and there was more hardwood cutting as a result of that, until intensive management efforts began which would be in the late 1960s.

Q. Now, Mr. Greenwood, I understand that before your examination-in-chief is completed that you wanted to address one of the submissions that I made to the Board during my opening remarks in relation to this panel.

MR. GREENWOOD: A. Yes. You made some comments concerning significance of effects and I just wanted to make a few statements on that before I finished.

In my evidence and in the evidence I led

today orally, it has been directed towards the effects on the forest estate and, therefore, the potential effects are the topics which I discussed on productivity.

In my opinion, normal practice takes into consideration that value; that is, site productivity. We saw the skidder operator who had put the poplar across the drainage way and that reflected a concern for rutting which is in fact a concern for productivity.

I wanted to ensure that the evidence was not taken to imply that occurrences never take place, they do, and some of my slides -- and through some of my slides I hoped to demonstrate that. The occurrences, however, are not severe or frequent or large enough, in my opinion, to significantly affect productivity which is the concern of the forest estate.

These concerns -- or these occurrences however may be significant in terms of other values and so when I was saying things such as erosion is not significant, I am speaking from terms of on-site productivity on the forest estate.

A lower degree of erosion, for instance that which would not affect productivity, may affect another value and, in my mind, this is the reason for

developing and using the guidelines in our management planning process. So I just wanted to make that point clear before we left these effects.

Q. And, Mr. Hynard, when you gave your evidence about not having seen erosion that was of concern or significant, in what respect were you giving that evidence?

MR. HYNARD: A. I was giving it in that same context.

Q. And, Mr. Oldford, are you able to indicate whether you were also referring to it in that same context?

MR. OLDFORD: A. In the same context.

MR. FREIDIN: Those are my questions for Mr. Greenwood, Mr. Chairman. I understand that you wanted perhaps to break at five o'clock. I think this would be obviously a convenient time to break and, again, I believe that we will finish tomorrow in good time for people to catch the 5:05 or the flights around that time.

THE CHAIRMAN: Okay. I think we will start tomorrow at 8:30 just to be sure.

MR. FREIDIN: Okay.

THE CHAIRMAN: Thank you.

We will adjourn until tomorrow.

---Whereupon the hearing adjourned at 4:50 p.m., to be reconvened on Wednesday, March 8th, 1989, commencing at 8:30 a.m.